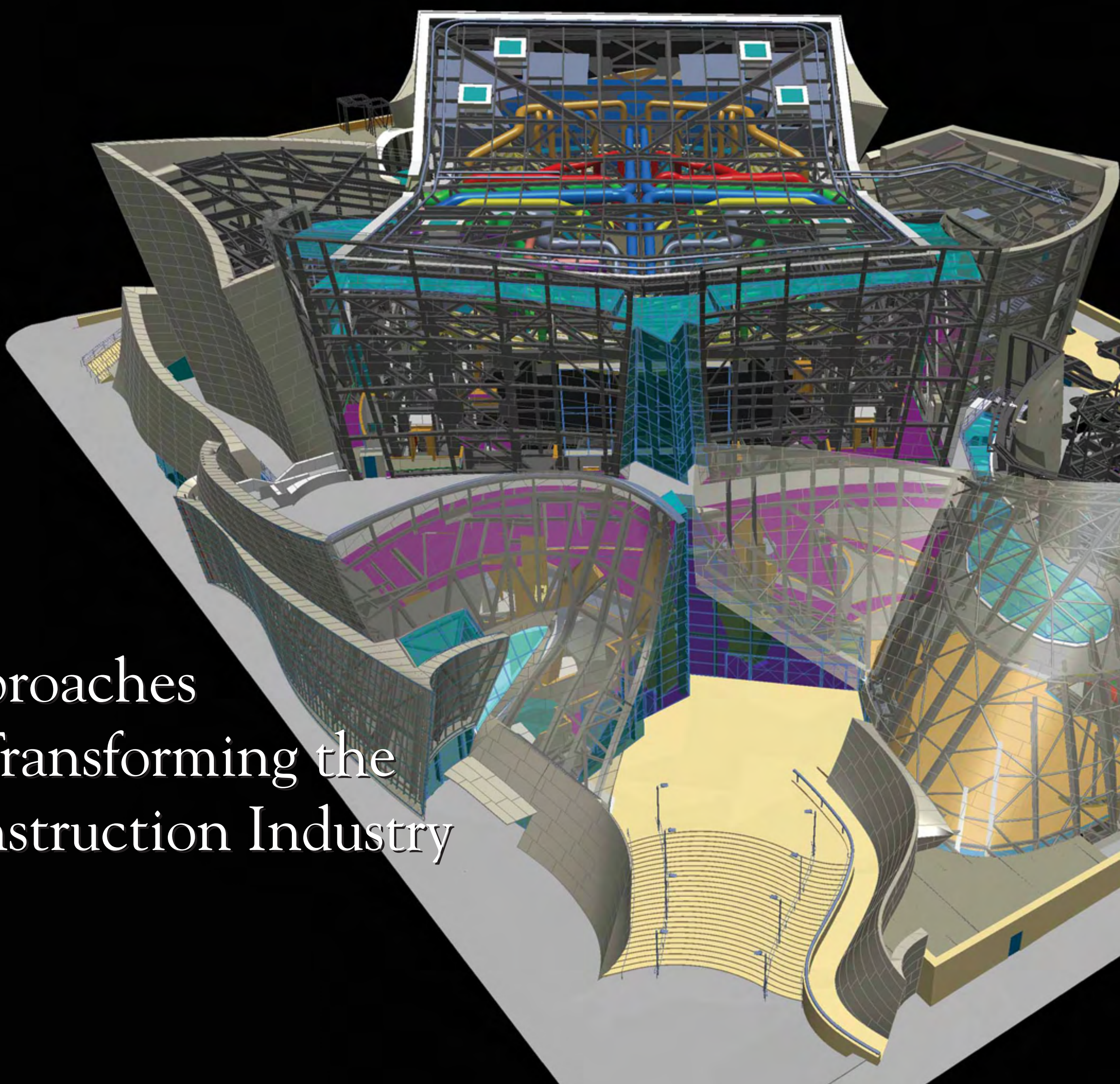
JBIM
Fall 2007

Journal of Building Information Modeling

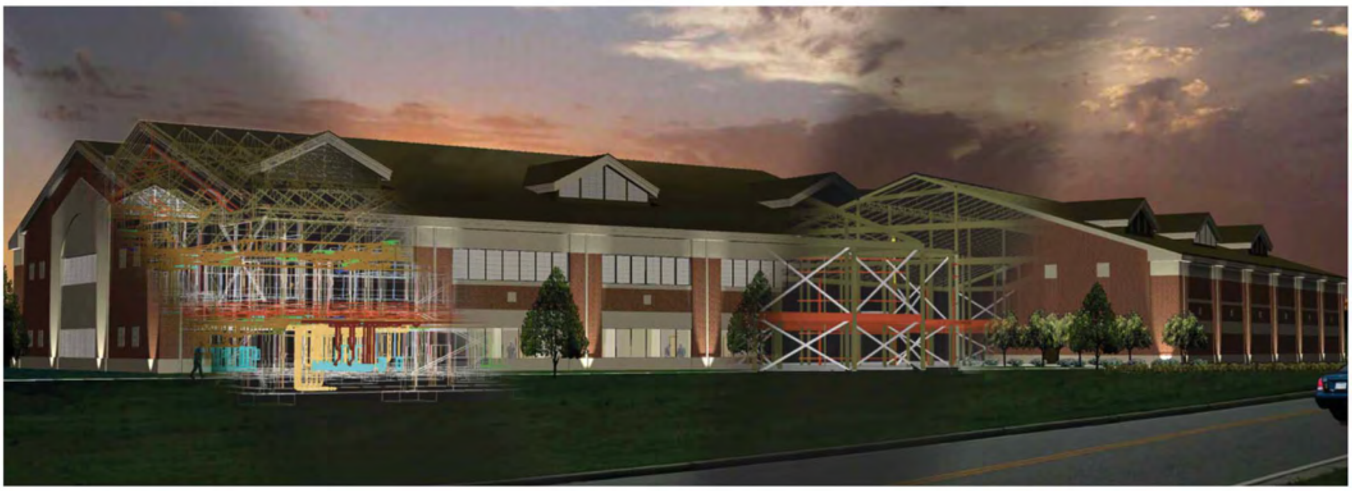
An official publication of the National BIM Standard (NBIMS) and the National Institute of Building Sciences (NIBS)

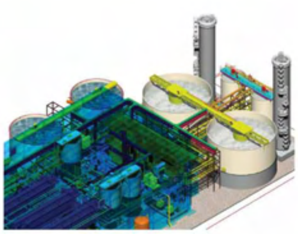
buildingSMARTalliance™

Not Your Parents' Way of Doing Business



Approaches to Transforming the Construction Industry





Contents

JBIM

Published For:
NBIMS/NIBS
1090 Vermont Avenue, NW, Suite 700
Washington, DC 20005-4905
Phone: (202) 289-7800
Fax: (202) 289-1092
nibs@nibs.org
www.nibs.org

Published by:
MATRIX GROUP PUBLISHING
Please return all undeliverable addresses to:
16516 El Camino Real
Suite 413, Houston, TX 77062
Phone: (866) 999-1299
Fax: (866) 244-2544

PRESIDENT & CEO
Jack Andress

SENIOR PUBLISHER
Maurice P. LaBorde

PUBLISHER & DIRECTOR OF SALES
Joe Strazzullo
jstrazzullo@matrixgroupinc.net

EDITOR-IN-CHIEF
Shannon Lutter
shannonl@matrixgroupinc.net

EDITOR
Jon Waldman

FINANCE/ACCOUNTING & ADMINISTRATION
Shoshana Weinberg, Pat Andress, Nathan Redekop
accounting@matrixgroupinc.net

DIRECTOR OF MARKETING & CIRCULATION
Jim Hamilton

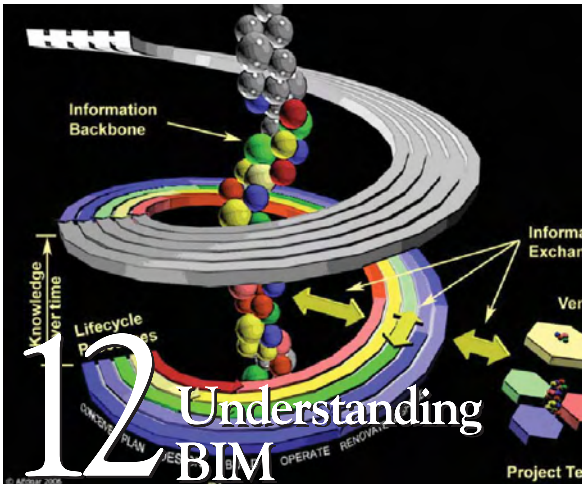
SALES MANAGER
Neil Gottfred

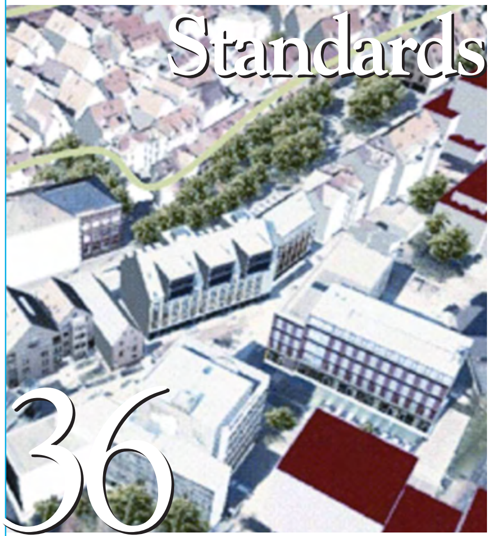
MATRIX GROUP PUBLISHING ACCOUNT EXECUTIVES
Travis Bevan, Albert Brydges, Lewis Daigle, David Giesbrecht, Rick Kuzie, Rosemary McColm, Miles Meagher, Marlene Moshenko, Declan O'Donovan, Ken Percival, Brian Saiko, Shayne Stephens, Vicki Sutton, Peter Schulz, Don Norman

ADVERTISING DESIGN
James Robinson

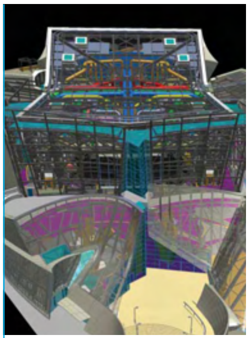
LAYOUT & DESIGN
Cody Chomiak

Features:

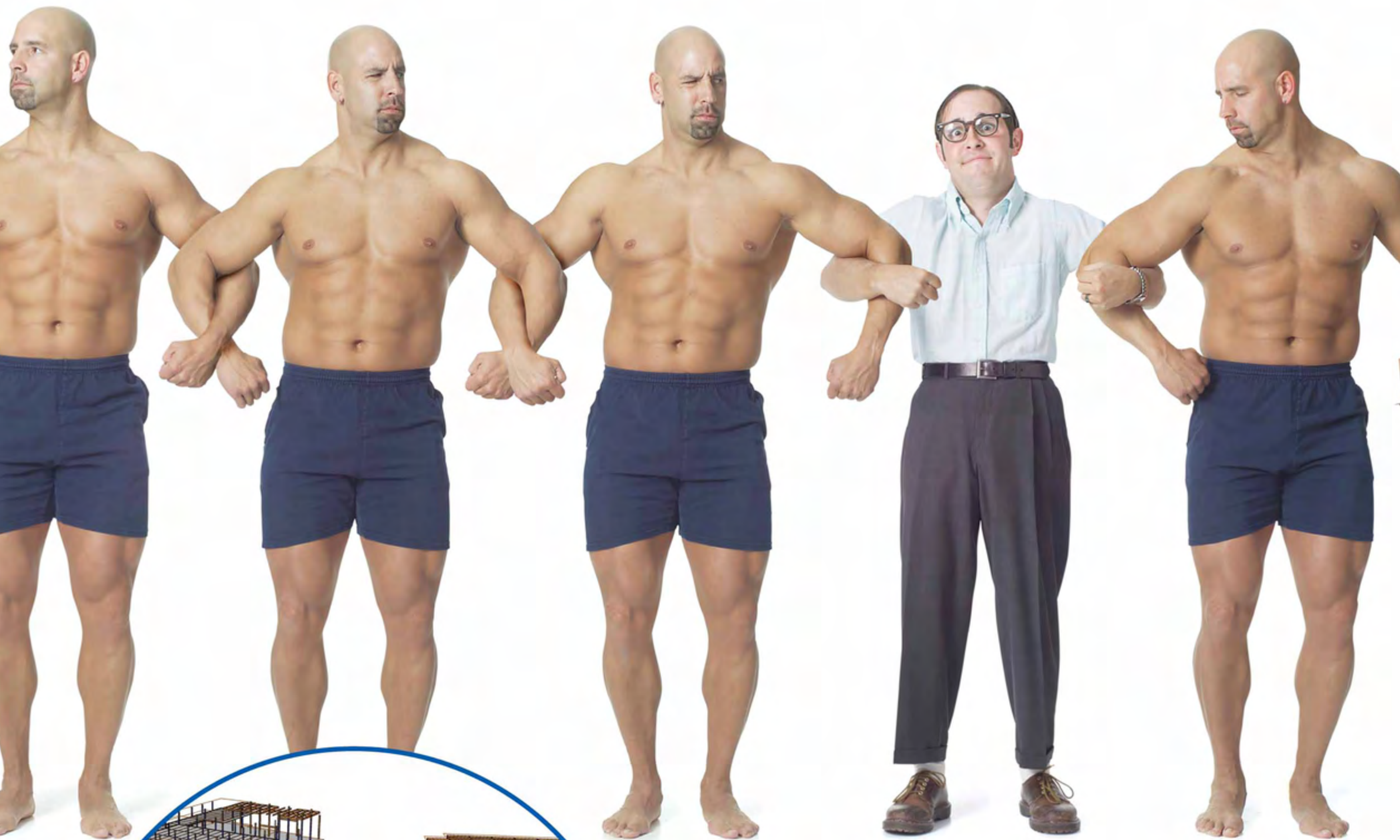


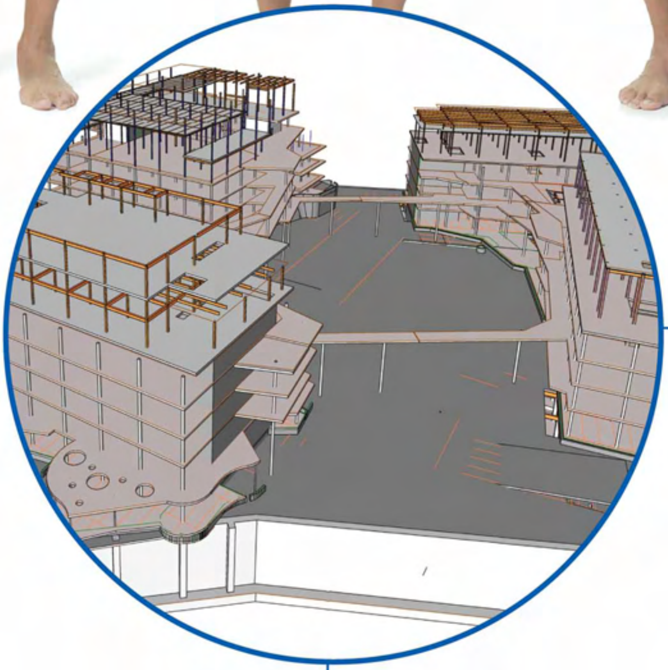


Messages:



On the cover: This transparent view of the Building Information Model (BIM) shows structure, cladding and environmental systems that were used to perform conflict analysis, visualization and subcontractor fabrication for a very creative and complex facility. The system Gehry Technologies uses for BIM is Digital Project V1, R3. Photo courtesy of Dennis R. Shelden, Ph.D., Chief Technology Officer, Gehry Technologies. The picture is of the Disney Conference Hall, designed by Frank Gehry.





David A. Harris, FAIA

"This new and significant journal will be an essential information source on business, standards and technical issues related to Building Information Modeling."

WELCOME TO THE JOURNAL of *Building Information Modeling* (JBIM)! The National Institute of Building Sciences (NIBS) and its Facility Information Council (FIC), National BIM Standard project committee and the buildingSMART alliance™ are delighted to provide you with this important publication. We are pleased to team with Matrix Group Publishing to produce this inaugural issue of the *Journal of Building Information Modeling*. We are planning to publish the magazine twice a year.

This new and important magazine will become an essential information source for all aspects of building information modeling. There is much to do to ensure the movement to the full use of BIM is successful. We need to be sure the best business practices and processes are incorporated, that we develop effective consensus standards, and provide and sustain the underlying technology. NIBS, through its buildingSMART alliance™ and other programs is deeply involved in many related activities. We believe that BIM has not only the power to profoundly improve the construction industry, but that it is a critical juncture for our industry domestically and internationally. With energy conservation, environmental stewardship, and sustainability all on the front burner of critical industry issues, BIM provides a common tool to dramatically improve our response to these vital issues.

BIM will be most successful when information created during design and construction is routinely provided to the operators and sustainers of facilities. This will eliminate the waste of re-gathering information. The information, sustained by the operators will be used throughout facilities' long lifecycles if it is collected and maintained using open standards that utilize interoperable software tools which share information across today's and tomorrow's applications.

Neither BIM nor our industry is static, thus, I encourage you to pursue continuous learning by reading future issues of *JBIMS* as well as keeping up to date using NIBS' Facility Information Council site web site at www.facilityinformationcouncil.org and the buildingSMART alliance™ site at www.buildingsmartalliance.org.

Please also visit the NIBS' Website at www.nibs.org. We encourage you to make use of our products, participate in our programs, and provide useful feedback on critical issues affecting the building industry in North America. Together we can successfully improve the performance of the built environment. We invite our readers to let us know how you like this issue and how it can be improved. Let us know how we are doing toward meeting our goal of providing a new and reliable source of information through which to enhance the implementation of true lifecycle and open standards based building information modeling. Please provide critical feedback to Matrix Group Publishing or to NIBS, so we can make this publication better and more responsive to your needs.

Kind regards,

David A. Harris, FAIA
President
National Institute of Building Sciences

JOIN US!

The National Institute of Building Sciences (NIBS) was authorized by the U.S. Congress in the Housing and Community Development Act of 1974, Public Law 93-383. In establishing NIBS, Congress recognized the need for an organization that could serve as an interface between government and the private sector.

The Institute's public interest mission is to improve the building regulatory environment; facilitate the introduction of new and existing products and technology into the building process; and disseminate nationally recognized technical and regulatory information.

TO JOIN THIS PRESTIGIOUS GROUP GO TO THEIR WEBSITE WWW.NIBS.ORG/MEMAPP.HTML.

Home, sweet hybrid home.

If cars are being built to be more energy efficient, why shouldn't homes? At BASF, we've put our energies into building an affordable house in Paterson, New Jersey, to demonstrate how truly energy efficient a home can be. Our Near-Zero Energy Home utilizes BASF's high-performance products in insulating foam sealants, panels and concrete forms, and is 80% more energy efficient than the average American home. Who says a hybrid should only come on wheels? Learn more at basf.com/stories

Helping Make Products Better™

BASF

The Chemical Company

Alan Edgar, Assoc., AIA

"The Committee recognizes that this is a deceptively simple concept requiring a great deal of cooperation for the good of all and, for this reason, frequent and open communication is a key success factor."

ON BEHALF OF THE NATIONAL Building Information Modeling Standard Committee, I would like to welcome everyone to the first edition of *The Journal of Building Information Modeling (JBIM).*

In December 2005 approximately 50 individuals, representing many hundreds more in sponsoring professional and industry associations, developers and vendors, gathered together under the auspices of the National Institute of Building Sciences (NIBS) to seek a solution to unacceptable losses due to inefficiency in the capital facilities industry. Although it seemed like a rather ambitious undertaking, many of the people and organizations present had been working individually for many years to address various aspects of the problem and now were gathered to discuss the benefits to be gained by coordinating approaches to improving quality, responsiveness, reliability and efficiency throughout the building lifecycle.

Since that meeting, many significant events have occurred including the formation and first products of the National Building Information Modeling Standard Committee (NBIMS) and recently formation of the buildingSMART alliance™; which will provide the umbrella for a wide range of organizations and activities that are positively transforming the industry and can be classified as "buildingSMART".

Now, through JBIM, the industry has a magazine dedicated to introducing and exploring new concepts and the profound effects interoperable lifecycle building information modeling and associated business best practices can achieve. In the NBIMS publication *Version 1—Part 1: Introduction, Principles and Methodologies*, the vision is expressed in this way:

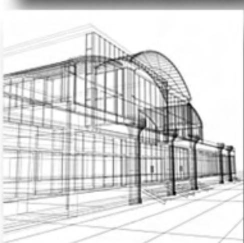
"Imagine for a moment all of the individual actors in all of the phases of a facility's lifecycle. Imagine that all of the actors, working in familiar ways within their own specialty areas, are able to gather information, explore options, assemble, test, and perfect the elements of their work within a computer-based model before committing their work to be shared with or passed on to others, to be built, or to be operated. Imagine further that when it becomes necessary to share or pass a bundle of information to another organization, which may or may not be using the same tools, or to move it on to another phase of work, it is possible to safely and almost instantaneously (through a computer-to-computer communication) share or move just the right bundle of information without loss or error and without giving up appropriate control. In this imaginary world the exchange is standardized across the entire industry such that each item is recognized and understood without the parties having to create their own set of standards for that project team or for their individual organizations. Finally, imagine that for the life of the facility every important aspect, regardless of how, when, or by whom it was created or revised, could be readily captured, stored, researched, and recalled as needed to support real property acquisition and management, occupancy, operations, remodeling, new construction, and analytics.

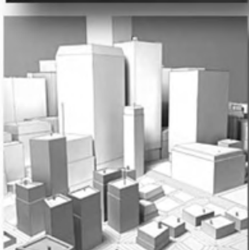
These scenarios are a highly compressed summary of the fundamental goals and challenges for the NBIMS Committee, the rationale behind the NBIMS Initiative, and the business solution the National BIM Standard will provide. They illustrate the need for the NBIM Standard to address the requirements of many types of users with hundreds of functional backgrounds and individual business viewpoints arising from the particular niche occupied within the building supply chain and throughout the lifecycle of a facility. To address the range of requirements, the NBIMS Committee, beginning with this publication, speaks to the business process aspects of open and interoperable information exchange standards as well as supports the beneficial use of computer systems and business best practices in every aspect of the facility lifecycle."

To accomplish this vision the industry needs new paradigms for many aspects of professional and trade operations, new expectations for efficiency and quality and new tools that eliminate unnecessary and redundant functions, and—maybe most importantly—businesses need a workable way to get from "here" to "there". For the NBIMS Committee this means focusing on standardizing business views of information needed when two or more parties wish to collaborate on a building process task and then facilitating the implementation of these information exchanges in computer software. The Committee recognizes that this is a deceptively simple concept requiring a great deal of cooperation for the good of all and, for this reason, frequent and open communication is a key success factor. In this endeavor then, JBIM joins the NBIMS website and listserv as a key communication resource to the community.

Alan Edgar, Assoc., AIA
Chair
National BIM Standard
Executive Committee







Building Information Management

Participants in the building process are constantly challenged to deliver successful projects despite tight budgets, limited manpower, accelerated schedules, and limited or conflicting information. Innovations in technology, most recently BIM, boast of capabilities to ease the pain of project delivery.

The unique nature of building projects means that productivity improvements depend more on right-sizing a technology solution for the demands of a process rather than any one software application. At Design + Construction Strategies, we specialize in analyzing a client's information needs and integrating a technology approach and process improvement to best serve their organization's strategic needs.

Visualization. The best means of understanding the built environment is through visualization. BIM provides its users with an 3D environment that echoes real world construction. In contrast to the 2D drawings that architects have traditionally used, BIM offers a means for clearer communication of a building design. A fully formed 3D model linked to supporting building data also offers the capability for downstream use of building information for users beyond the initial AEC participants.

Design + Construction Strategies is experienced in extending the concept of 3D building information models beyond project documentation. Using a BIM-based model as a visual portal to a database of building information can make a wealth of information easily accessible to the user. We are experts in integrating a wide range of technologies to extend management of the built environment: BIM software, analysis tools, simulation applications and relational databases.

Information Integration. Design + Construction Strategies employs gaming and animation applications to provide simulation environments for tasks that might include life safety analyses, campus management, scenario planning, 4D visualizations and emergency response. We developed the U-Vis 360™ simulation environment for Autodesk, integrating a building information model into an urban geospatial context with a game engine and relational database connection to provide a simulation environment for urban military operations.

Using NavisWorks software, DCS can integrate models from multiple disciplines and apply the 4th"D"– time - to 3D models, illustrating project scheduling and sequencing. Construction data models can be quite different from architectural BIMs; they are more data intensive and require more interoperability amongst project participants for clash detection and resolution, project staging, and fabrication.

Increase ROI – Improve Productivity and Reduce Cost. The advantages promised by employing new technologies are meaningless unless project participants realize gains from the considerable efforts required to adopt new tools and practices. DC Strategies has experience in a range of applications designed to work with BIM including such costing applications as Innovaya, US Cost, Trelligence, dProfiler and BuildingExplorer as well as others.

DC Strategies also works to refine an organization's business processes to better utilize technologies based on its unique needs. We helped the US Department of State's Overseas Building Office evaluate existing work processes and data in order to define a visual software planning and costing application aligned with their business needs. We are also consultants to the International Code Council (ICC) on their innovative SMARTCodes project.

When process and ROI matter, successful businesses turn to us

Design + Construction Strategies
11 Dupont Circle, Suite 600 • Washington, DC 20036
202.222.0610 • fax 202.222.0609 • www.dcstrategies.net


AEC Infosystems
Member Building Smart Alliance
National BIM Standards
We Put the "I" in BIM
"When it comes to solving real world problems with BIM and related technologies, no other group brings the proven track record of success, depth of expertise, and best practices that AEC Infosystems / Onuma delivers."
David Hammond, USCG Roadmap
Clients Include:
USCG, DHS, GSA, Smithsonian Institution
Architecture, Design-Build, Construction
GSA # PJ7N02916
1-800-246-3348
www.aecinfosystems.com
Consulting
Data Integration
Visual Decision Support
Vision & Implementation Support
BIM Process Modeling
Teaming and Collaboration
Products for BIM+Project Integration


Element Properties
Family:
Type:
Edit / New
Welcome
to the Future.
www.hok.com

An Introduction to Building Information Modeling (BIM)

By Deke Smith, AIA

A BUILDING INFORMATION MODEL is a digital representation of the physical and functional characteristics of a facility. As such it serves as a shared knowledge resource for information about a facility forming a reliable basis for decisions during its life-cycle from inception onward. A basic premise of the model is collaboration by different stakeholders at different phases of the life cycle of a facility to insert, extract, update or modify information in the modeling process to support and reflect the roles of that stakeholder. The model is a shared digital representation founded on open standards for interoperability. The model may be a database made up of a set of interrelated files and not just one entity.

The concept of Building Information Modeling is to build a building virtually, prior to building it physically, in order to work out problems, and simulate and analyze potential impacts. The heart of Building Information Modeling is an authoritative building information model.

The reality is that all information for a building already exists electronically is the catalyst which makes implementing BIM a possibility. Our challenge therefore is to pull all the information together for the specific building being developed. The creation of a building information model begins with the first thoughts of the project. From that point forward the model is used as the authoritative source for information about the building. The model should be complete in every way prior to construction and all conflicts or clashes between building systems have been worked out prior to physical construction beginning.

This means that all the products that go into the model will have been selected and the fabricators will have participated providing the connection details. Each party will do their same job, simply more rapidly in a more collaborative environment. Once conflicts have been eliminated the model is locked. Detailed analysis can be run on the model at all stages to determine the optimum energy usage, the most sustainable and lowest lifecycle cost and the most environmentally friendly facility possible. The model also links to the geospatial world which provides it real world context. It also is in sync with the real property community so that the information is usable by all parties involved with facilities.

The construction contractors and sub contractors will build from the model without deviation. If something is not in the right place then the sub-contractor who deviated from the model will go back and make it right. The model will not be adjusted. As the building is assembled detailed information about the products being installed is collected from invoices and other delivered product information, items such as serial numbers, who installed it, and when the warranty period runs through can be collected and stored. What preventative maintenance is required will also be stored in the model and later used to generate work orders.

The work site is safer because more items will be pre-assembled off site and trucked to the site keeping the on-sire trades to a minimum. Waste will be minimized on-site and products will be delivered when needed and not stockpiled on site. Fabricators will also reduce waste because optimization of tasks such as cutting of sheet metal and pipe can take advantage of all scrap. More things are built and pre-assembled off site in controlled environments. When complete the model will be delivered to the operator and sustainer of the facility and any modifications or improvements will be recorded in the model. The model is the authoritative source and it will be used to plan and

Continued on Page 14

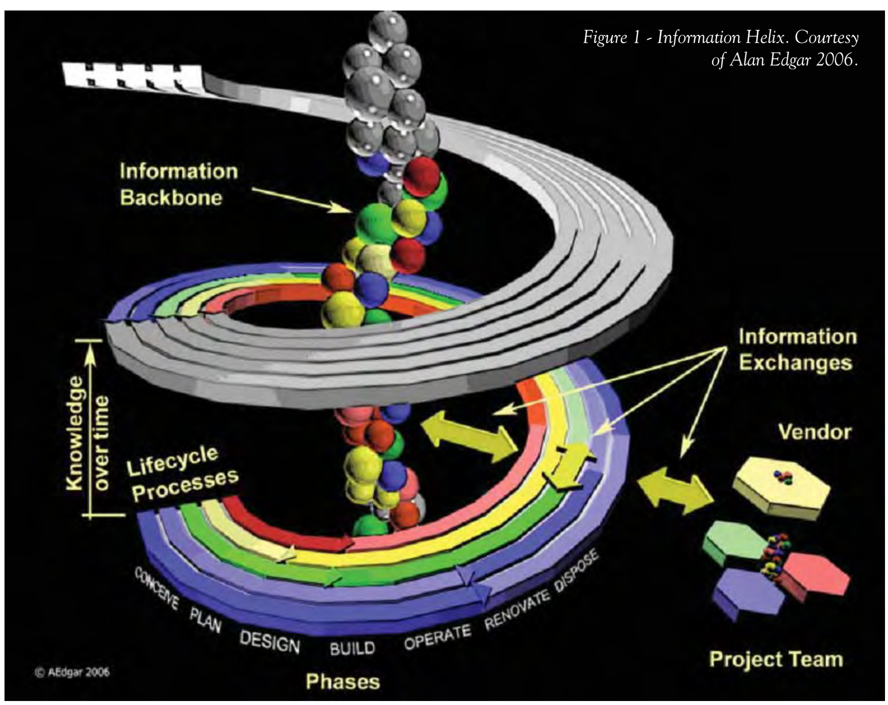


Figure 1 - Information Helix. Courtesy of Alan Edgar 2006.

"The concept of Building Information Modeling is to build a building virtually, prior to building it physically, in order to work out problems, and simulate and analyze potential impacts."

Continued from Page 12

execute changes throughout the life of the facility. The work order supporting those changes will be tested for effect on the rest of the model and will not be closed until the model is updated and validated to be in compliance with the original design intent and energy usage plan. This continuing collection of data and building of knowledge at various stages is depicted in **Figure 1**.

Is this vision a long time in the future? No, actually there are some early adopters doing major parts of it already, although no one has implemented the entire vision. General Motors, for example, is on its sixth major project and they have saved nearly 25 percent over conventional design-build approaches. The United States Coast Guard has also implemented major aspects of BIM and is leading in the operations and sustainment aspect as they are linking facilities to mission requirements. There are many other examples of profound changes to the historical business processes used to build facilities.

This effort is not limited to the United States. Twenty-five other countries are participating in the buildingSMART® effort. Each is learning from and contributing to the advancement of this business process re-engineering effort. The key to success is in fact changing your business practices, not simply buying software. In fact software is the least cost investment in developing a BIM approach and that decision should be made after you determine your requirements.

Getting started is actually not as daunting as some perceive and it is predicated on knowing what functions you want to implement first. The first step is to simply decide that the building information model is going to be your authoritative source for all information about the facility. This decision can apply to new, as well as existing facilities. Your long term view must focus on the data and not the tool, if you plan use this model for a hundred years or longer—the life of the facility. This is critical so that you are not bound to the success or development schedule of a single tool vendor.

You may want to start with 3D visualization and conflict resolution, and then add various design and analysis tools once you have a basic model. Structural engineering and energy modeling are some of the typical next additions. Code compliance checking is maturing and will be ready in the United States within a year. The challenge with that is getting local municipalities to adopt the new approach. In time you will implement a complete collaborative, virtual and integrated design and construction approach so that you are achieving the first part of the vision described above. We need to ensure that facility managers are aware of the level of information that we have the potential to pass to him so that he adjusts his business processes to accept and sustain the information with little or no additional effort.

Building Information Modeling is much more than the building information model itself, it is truly the re-design of a whole industry. The National Institute of Building Sciences, a non-government non-profit organization established by congress to coordinate government and private sector construction entities has taken on this larger more holistic vision of BIM with the launching of the buildingSMART alliance™. The buildingSMART alliance™ is focused on incorporating the necessary business process changes, business case development, return on investment models along with the standards and the educational coordination required to profoundly and substantially improve the industry.

It is our hope that this magazine provides you with the information needed to help you launch and build your understanding of Building Information Modeling and learn from the many talented people working on this international effort to transform the construction industry. ■

Dana K. "Deke" Smith, AIA is the Executive Director of the buildingSMART alliance™. While working for the Department of Defense he founded the Facility Information Council, the home of the National CAD Standard and the National BIM Standard. Smith retired from the government after 30 years of service, in December 2006. In addition to his NIBS duties he has an information consulting firm and is a senior analyst for Cyon Research and the International Centre for Facilities in Ottawa. As well he is writing a book on the strategic planning for implementing BIM.

What is BIM?

Building Information Modeling (BIM) is a digital representation of the physical and functional characteristics of a facility. A BIM is a shared knowledge resource for information about a facility, forming a reliable basis for decisions during its life-cycle; defined as existing from earliest conception to demolition.

A basic premise of BIM is collaboration by different stakeholders at different phases of the life cycle of a facility to insert, extract, update or modify information in the BIM to support and reflect the roles of that stakeholder.

LEAN, Green and Seen

The issues of societal needs, business drivers and converging technologies are making BIM an inevitable method of delivery and management of the built environment

By Dianne Davis, Scoping Chair National BIM Standards

"*YOU CAN'T BOIL THE OCEAN*" is a phrase often used when a task seems too large to accomplish. It's a phrase that's been used for many years regarding change in the AEC industry. However, during the last few years it has been seen that humanity has the real potential to boil the oceans.

The AEC industry has a close connection to climate change. The built environment consumes 40 percent of global raw materials. In the United States 136M tons of construction waste and 65.2 percent of electrical power is consumed by buildings each year (according to the U.S. Department of the Interior).

As a global industry, in which the U.S. is only one of the consumption leaders, there is a huge need to reduce all types of waste, maximize and sustain all types of resources, and be able to show what we know to deliver products and services in the most effective ways possible. Reengineering how we think, work, share and use knowledge can produce the sustainability changes in industry processes, delivery and products allowing the AEC industry to go "green".

BACKGROUND ON PROCESS

The construction industry has suffered a 20 percent decline in productivity as compared to other industries. It is generally accepted that there is approximately 30 percent waste in our processes and delivery methods and a NIST study calculated a yearly loss of $15.8 billion dollars due to a lack of information sharing and process continuity (www.bfrl.nist.gov/oae/publications/gcrs/04867.pdf).

Statistically, information is re-created and/or re-entered five to eight times in a project lifecycle. Studies by Shell estimated that 16-17 percent of IT time could be eliminated if this re-entering of data could be eliminated from project execution. Some believe this statistic may be higher in the AEC industry because the building industry is not as highly organized as the process plant environment.

In the manufacturing world studies show a 30-40 percent waste in the design activity. Design waste occurs most often due to incomplete information, imperfect knowledge of requirements, available technologies, or of the market being addressed (www.ugs.com). There is a 30 percent wait-time for information calculated for the construction process.

This waste in time, human capital and IT capability is impacting the industry's ability to be efficient, to make better informed decisions and to be effective collaborators and information providers.

The AEC Industry is evolving:

FROM	TO
Paper-centric	Digitally enabled
Project-centric	Lifecycle sustainability
Stovepipes	Collaboration
Tracking time	Quantifying value
Supposition	Simulation
Outputs	Outcomes
Conversation	Communication
Info-centric	Knowledge management

If global sustainability is a significant reason *why* this industry should change, then LEAN methodologies, BIM and e-enabled business processes with open standards are *how* these changes can come about in a sustainable way supporting the entire building lifecycle.

By incorporating LEAN thinking[1] supported by new business processes, BIM and tools that simulate and enable more informed decisions faster and the automated creation of information, the industry can share the right information at the right time. LEAN, sustainability or green and BIM technologies and processes are the foundation of successful evolution within the industry.

LEAN THINKING, BIM AND SIMULATION

In 1990 Jones and Womack wrote "The Machine That Changed the World" in which they coined the phrase "LEAN Production" to describe the type of manufacturing methods and results found at Toyota. At its heart is LEAN Production. This is about creating value for the consuming customer and eliminating everything else that does not directly contribute to this value creation, i.e. waste.

To support this thinking about waste reduction, the manufacturing industry has moved to virtual simulation for LEAN product design. BIM and related technologies represent this comparable ability in the AEC industry. It is sometimes called Virtual Design and Construction (www.leanconstruction.org). This growing and diverse set of tools specifically around the AEC industry simulation needs are being produced all over the world. These form the foundation of new process approaches and in order to maximize and operations flexibility to use any tool open information standards are required. Another requirement is flexibility and change in process.

Culturally companies in the AEC industry have not seen IT on projects as core or a strategic business activity. This varies amongst the stakeholders, but the majority of AEC organizations purchasing BIM tools are still mimicking a manual process and have not taken this as an opportunity to re-structure internal methods of work to be more IT enabled, LEAN and collaborative.

Those moving to new processes and collaboration are developing these activities internally or with a few select partners. It looks too large to manage at an industry scale.

LEAN thinking within design, construction and operations adjusts the culture to focus on the development of the right information at the right time. It is created in the most effective and efficient ways to support better decisions and information re-use at all levels of an enterprise and can be re-purposed across all stakeholders.

Two examples of this type of thinking are the mission/business to facility and funding streams simulation through BIM models created as a pilot within the U.S. Coast Guard Roadmap.[2] Another example is General Motors use of Clash Detection Simulation to discover conflicts prior to actual field construction. By changing the process both organizations take advantage of the available tools and reduce waste in human capital, materials, design, construction and management costs.

In development are additional analysis tools by the International Code Council for Code Checking. GSA developed a guide and checking for space and others are working on ADA compliance checking and security checking.

As BIM models move beyond geometry creation for documentation and into the realm of decision support, the need for more intelligence and standardized information use becomes apparent.

These tools require specific data sets because it is the interrelationship of this data that produces the analysis. This makes IT and information at the center of the BIM process.

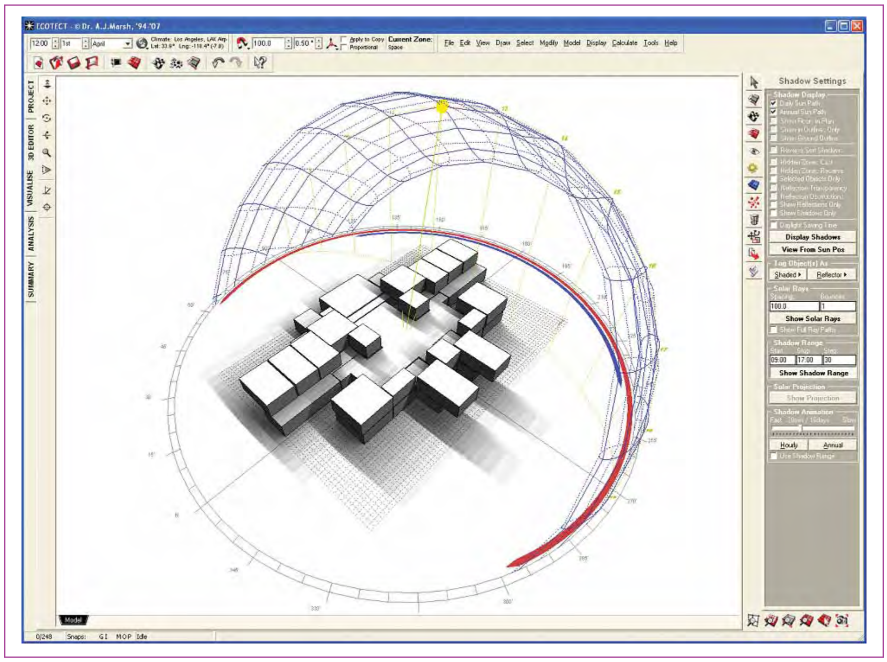
CHANGING AWARENESS

Over the last six years and since 9/11, the awareness of the convergence of activities supporting change within the industry has quickened but still remains extremely diverse and uneven. A Google search of "Building Information Modeling" produces 211 million listings, "Building Information Modeling and sustainability" produces 7.58 million listings, while a search representing activities underway to support this change "Building Information Modeling, BIM Guides, sustainable design, LEAN, IAI, AIA-TAP, buildingSMART alliance™, and open standards," produces less than 100 listings.

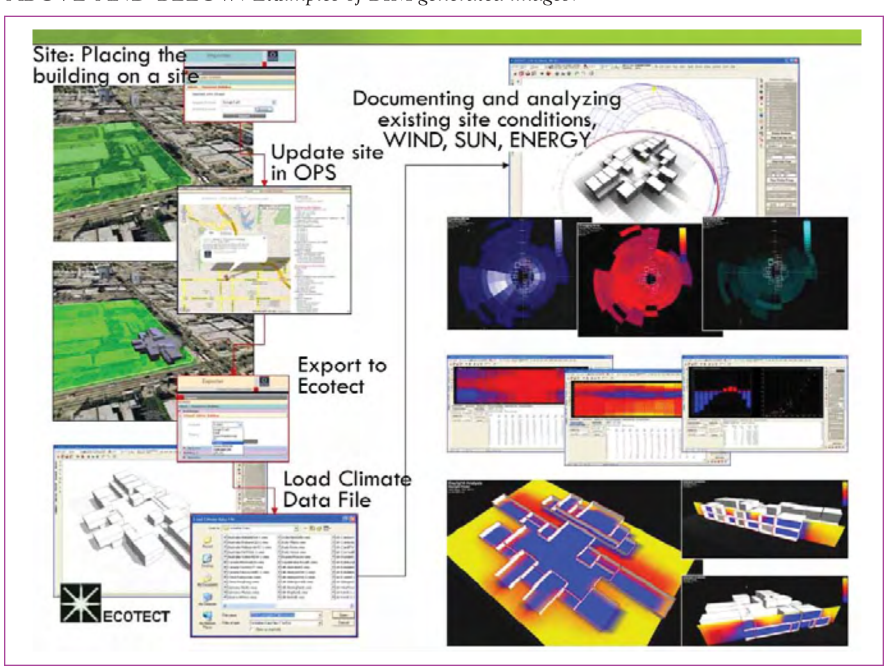
This progression of Google listings represents a huge "buzz" around the technologies due to marketing; on the other hand it identifies a real gap concerning how and what is needed to implement BIM, LEAN and green.

The FMI/CMAA Sixth Annual Survey of Owners reported once again that problems with co-ordination and collaboration among team members was near the top of the list of concerns that keep owners awake at night. This survey of the largest building owners in the world states that "successful owners build a culture of ownership through the construction process to align the stakeholders and achieve desired project outcomes and program goals." A key ingredient in aligning stakeholders is efficient communication and collaboration.

By the 2007 report owners sited five critical areas: material costs, aging workforce, globalization, BIM, and LEED/Green Building absent a holistic strategy. All are big-picture strategic issues to address and resist tactical solutions. CMMA realized in



ABOVE AND BELOW: Examples of BIM generated images.



the report that owners, contractors, engineers, architects, construction managers, program managers and building material/equipment suppliers working collectively are much more likely to impact these issues than a single organization working alone (http://cmaanet.org).

Owners have been vocal in their desire for better service and products and see technology use and process improvements supported by BIM and LEAN as a way of pushing service providers to meet their needs. In turn professionals are searching for a true understanding of what BIM, collaboration, process change and data sustainability mean to their companies and risks on a project.

While some groups are moving rapidly into that 21st century info-centric value chain delivering new value as envisioned by the NIST report ideal, others are stepping carefully or refusing to change.

The professional organizations are each addressing these issues from their constituencies' vantage point. There are now at least six BIM guides and roadmaps addressing BIM and IT use from specific stakeholder perspectives. These are fine examples of work but the collection of ideas and thoughts do not yet create a cohesive and sustainable enterprise process for the building lifecycle.

BuildingSMART and NBIMS represent activities which take a holistic or LEAN view of the issues and represents a level of harmonization blending all stakeholders' voices into a sustainable IT enabled process (www.facilityinformationcouncil.org/bim/publications.php) that can be enterprise or industry wide.

LEAN thinking applied to information creation changes our view of information services in the AEC industry. Data developed as BIM models is a strategic investment and asset for all involved. Information in a BIM is not a static snap shot as in 2D drawings. It is information capable of supporting reporting, more robust data aggregation than database tagging to 2D drawings and finally BIMs support simulation tool deployment.

These differences in process and approach allow the AEC industry to tackle the fundamental issues of change and problem solving. We can use BIMs and related technologies to answer questions not yet asked. BIM allows us to show what we know and to produce and document better more informed decisions faster. The re-use of information rather than its recreation reduces waste and maintains higher quality information in the delivery and management of each building. BIM data can be re-purposed beyond its current understood use breaking down the primary output into constituent parts for other uses.

This accumulation and consistent use of data about the built environment will allow us to move to a higher level of management, one building, one dataset, on information exchange at a time. That is how to boil the AEC ocean. ■

Dianne Davis is Scoping Chair of NBIMS. She has been working with BIM implementation for twenty years and shared the FIATECH CETI Award for Technology in 2007 with Onuma, Inc.

REFERENCES

[1] Lean Thinking, James P. Womack and Daniel T. Jones.

[2] Simulation developed by AEC Infosystems with Data from Mactec using ArchiCAD, Vertex Data and Common Point Softwares.

Building Information Models and Model Views

By Richard See, Managing Director, Digital Alchemy

IN THE LAST FEW YEARS, we have seen a great deal of marketing and press about Building Information Modeling (BIM). By now, most people in the industry must have a vague understanding of what BIM is, but may find some additional background, some specific examples, and more detail about how BIMs will improve quality, reduce costs, and enable new business processes should be of interest to most.

This is the first in a two-part article that will provide background about the evolution of building modeling concepts and systems, why product neutral BIMs are important, and how such BIMs will enable intelligent data sharing and enable the AECO industries to realize the kinds of efficiencies and quality improvements enjoyed by manufacturing industries today. Part 1 of this article provides background on building modeling, the larger context of product models, and initiatives to define a global standard for BIMs. Part 2 of this article will introduce the notion of Model Views, which are much like database views, how these views are defined, and how they will ensure predictable interoperability experience when used for exchange of BIM data between applications.

EARLY BUILDING MODELING SYSTEMS

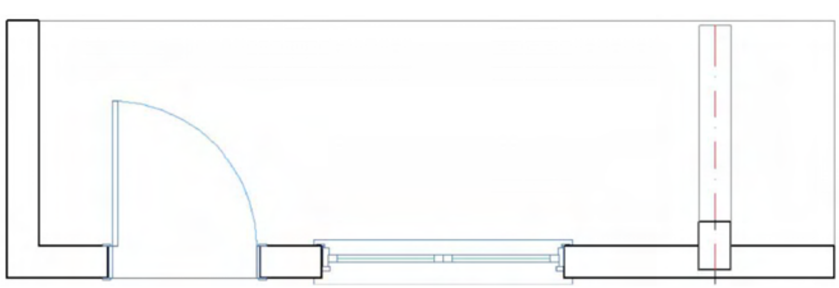
The notion of building modeling is not new. As early at the mid 1970's the UK government funded research in this area that ultimately led to early building modeling systems including BDS (Building Design System) and RUCAPS which were used by early adopters in the UK and U.S. through the mid 1980s. Even these first generation building modeling systems included some of the concepts central to today's BIM authoring software. Concepts including parametric element definition, building element libraries, multiple representations (graphic and analytic), and drawings as view or graphic reports generated from an integrated building model.

RUCAPS was replaced by a second generation building modeling system called SONATA in 1986 and saw much wider adoption, particularly in the UK, although it was limited by the fact that it required a workstation computer when other drafting oriented CAD systems would run on personal computers. However, in this same timeframe, a PC based building model system, ArchiCAD, was maturing and beginning to build a user based that continues today.

In parallel, the GLIDE (Graphical Language for Interactive Design), GLIDE-II, and CAEADS (Computer Aided Engineering and Architectural Design System) systems were developed by the CAD-Graphics Laboratory at Carnegie-Mellon University. Although not released as commercial products, they introduced more advanced solid modeling geometry for use in designing buildings and integrated database techniques to support more sophisticated models and extending the association of data with geometric representations[1]. These techniques were later adopted or emulated in commercial products.

These early systems were generally developed by people in the building industry that had a vision of using the computer to prototype buildings as assemblies of building elements rather than using the computer to create the same design drawings that had been used to describe buildings for centuries.

An example of a 2D image.



PRODUCT INFORMATION MODELS

Throughout the 1980s, similar modeling initiatives emerged in various manufacturing and more specialized construction industries. Common interests and needs in these groups and projects eventually led to the formalization of the concept of Product Information Models and development of STEP (the Standard for the Exchange of Product Model Data) and ISO standard 10303.[2] STEP has vigorously supported and widely adopted in the automotive, aerospace, process plant, and ship building industries, where the benefits of Product Information Modeling (improved information sharing, efficiency, and quality) have been widely observed and reported in the past decade.

One perspective is that the concept of Product Information Models, as introduced by STEP, formalized, harmonized, and standardized of concepts developed in many of the earlier projects and products (some of which are cited above). A Product Information Model can be thought of as a database of the product to be manufactured. That database can include a wide array of information about the product, including geometry, material, manufacturing and assembly techniques, tolerances, costs, and even information to support supply chain management, or it may include only some of these. The significant improvement of Product Information Models (and the pioneering products mentioned above) over previous product representations is that they are integrated information sets, which means data is referenced rather than repeated. This elimination of redundancy and reuse of data can/should lead to improved consistency, accuracy, efficiency, and quality—all of which lead to better products and productivity.

BUILDING INFORMATION MODELS

Building Information Models or BIMs should be thought of as the building industry's application of Product Information Modeling concepts where the product is a building.

Early implementations of BIM have been very "geometry centric", but this is beginning to expand now to inclusion of properties for use in analysis applications like energy use simulation, quantity take-off, cost estimating, construction planning and various types of engineering analysis.

As with Product Models, a BIM can be thought of as a database of the building project. The information in this database will someday span the full range of data we now manage for building projects, but as an integrated data set. As such, BIMs are multi-representational, multi-dimensional, and integrate the information created by many industry domains.

Figure 2 is a simple example of BIM objects, properties, and relationships.[3]

Continued on Page 24

Figure 2 – A simple example of BIM objects, properties and relationships.[3]

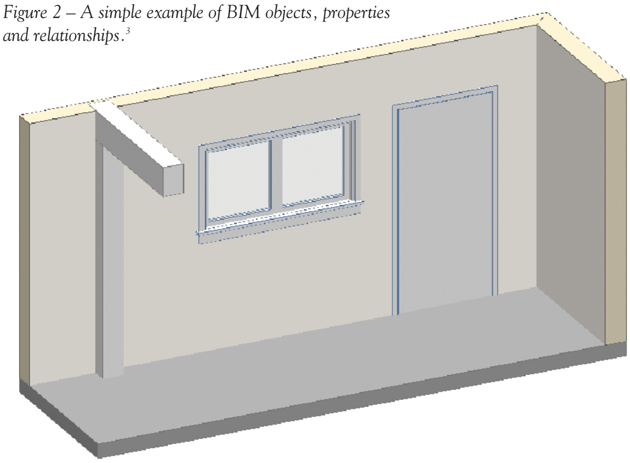
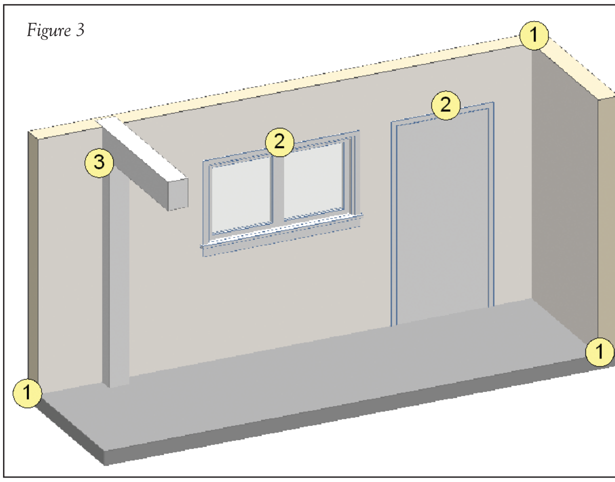


Figure 3



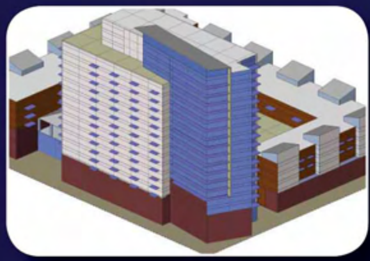
Beck Technology
Innovation in All Dimensions

Answering the “What Ifs” for the Architecture, Engineering and Construction Industry...

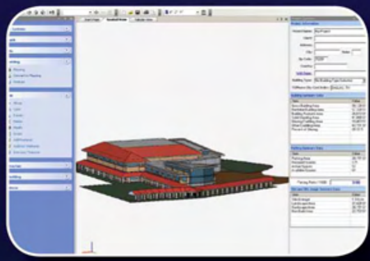
DProfiler

Beck Techology, LLC.
1807 Ross Avenue, Suite 500
Dallas, Texas 75201
214.303.6200 214.303.6300f
www.beck-technology.com

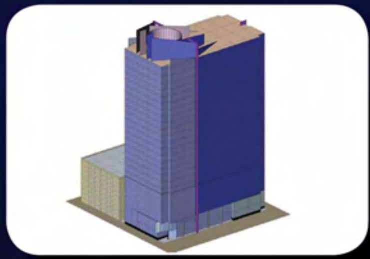
GRAPHICALLY DEFINE A PROJECT



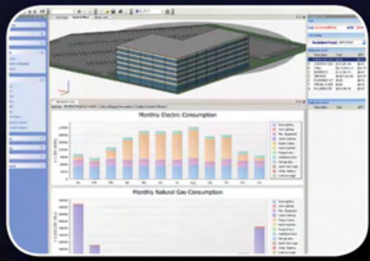
DERIVE PROJECT COSTS IN REAL-TIME



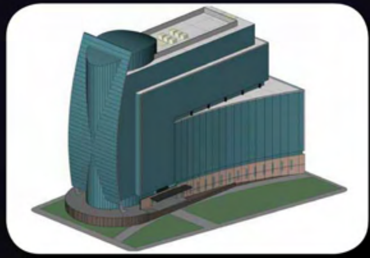
COMMUNICATE PROJECT SCOPE TO ALL PARTICIPANTS



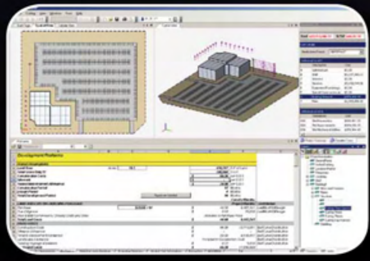
COMPUTE PROJECT OPERATING COSTS



DETERMINE A PROJECT'S IMPACT ON THE ENVIRONMENT



RAPIDLY MODIFY ANY ATTRIBUTE OF THE PROJECT AND KNOW IN REAL-TIME ITS RAMIFICATIONS



Continued from Page 21

Objects

BIM Models contain many types of objects. The most commonly understood are object representing the physical elements of the building. Our small example includes:

- Wall;
- Door;
- Window;
- Column;
- Beam; and
- Floor slab.

But BIM models also include many other object types that define abstract concepts and relationships like: relationships (for example connection and adjacency), object type definition (for example wall type and door type), hierarchies (for example containment), grouping (for example zones and systems).

2D geometry

2D Plan drawings are generated as geometric views or reports of the "plan" shape representations of the objects in the model. It is important to note that the "plan" representation uses industry standard symbolic graphics (e.g. door swing) whereas the "3D" representation uses 3D physical geometry. The image on page 20 shows two separate representations of a single object.

3D geometry

3D views are generated as geometric views of the "3D" shape representation.

Properties

Properties are attached to BIM objects to identify or describe them in some way. The range of possibilities for these properties is as wide as all the contexts in which they will be considered in a project, from design through construction and operation. Typically such properties are initially defined in a BIM authoring applications and can then be used by analysis and simulation applications to assess design performance (for example, thermal, structural, and quantity/cost).

Relationships

Capture and management of relationships is a key area in which BIMs improve upon processes and software tools used in the past because they enable a higher level of model analysis than properties only. For example, adjacency and connection relationships between spaces are what enable automated egress checking in a building model.

Our example includes all of the following relationships (See **Figure 3**):

Visible

1. Connection;
2. Voids (an opening in the wall); and
3. Supports.

Not Visible

1. Bounds (walls, floor bound space);
2. Contains (Project>Building>Story>bldg elements and space); and
3. Connects (space to door, window, and adjacent spaces).

Early implementations of BIM have been very "geometry centric", but this is beginning to expand now to inclusion of properties for use in analysis applications like energy use simulation, quantity takeoff, cost estimating, construction planning and various types of engineering analysis.

BIM STANDARDIZATION AND INTEROPERABILITY

Standardization is a logical step in the evolution and adoption of new technologies and processes as it can and should enable a next level of efficiency and adoption to industry.

Standardization for BIM logically followed the path taken for standardization of Product Information Models in STEP. This began in 1994, when a then fledgling AEC team (including the author) at Autodesk began development of a standard library of building model elements as the basis for interoperability between AEC add-ons to AutoCAD. Success in the initial prototyping eventually led to the formation of the Industry Alliance for Interoperability (IAI), which included 12 industry leading companies, led by Autodesk, that developed the original Industry Foundation Classes (IFC). IFC was introduced as the "common language for interoperability in the building industry" at the 1995 AEC Systems conference in Atlanta. All 12 companies demonstrated prototype applications (AutoCAD and Add-ons) that interoperated on a shared building model.

Seeing the industry excitement generated by the initial launch of IFC, the IAI member companies made the decision to open its membership to all companies in the building industry. By the end of 1995, there were several international chapters and hundreds of member companies in the renamed International Alliance for Interoperability (IAI). Several "Domain Teams" were also formed, to define the end user processes to be served by a first public release of IFC specifications for a standardized BIM.

Design and development of IFC by this larger, more international alliance was very much influenced by STEP and in fact, IFC makes use of many parts of the STEP standard, including: the EXPRESS modeling language, the STEP physical file format, and schemas for geometry and topology.

Release 1.0 of the IFC Schema for BIM was published by IAI in January 1997, IFC Release 1.5 followed in November 1997, and IFC Release 2.0 April of 1999. To date, there have been 7 releases of IFC, as described on the IAI web site (www.iai-international.org). The current release is IFC 2x3. Each of these, beginning with 2.0, could be exchanged between applications using the STEP physical file format (.IFC) or an XML data file format (.XML, .IFX).

Support for the proposed standard in software products lagged, as with any new standard, but began to accelerate quickly when government and large building owner organizations (e.g. US GSA) began to require the IFC BIM submissions in the past few years.

MODEL VIEWS FOR SPECIFIC EXCHANGE SCENARIOS

The IFC standard for BIMs is very large—so large that no single application will implement the entire schema other than model servers. As such, IFC can be thought of a framework for many common data exchange scenarios (e.g. the model subset shared by the architect with the structural and MEP engineers during conceptual design).

In 2000, the BLIS Consortium introduced a standard process and toolset for identifying these standard end user use cases, documenting requirements, and specification of implementation guidance as Model Views. These processes and tools were later improved to become the Information Delivery Manual (IDM) and Model View Definitions (MVD). Very recently, these processes and toolsets have been integrated. This integrated process will be proposed to the IAI in November 2007, as a standard methodology for requirements definition, IFC based solution definition, software implementation, and data validation in building industry projects.

The U.S. National BIM Standard (NBIMS) council in the National Institute of Building Sciences (NIBS) has adopted this process for development of a National BIM Standard. Once this standard is supported in shipping software applications, it will enable the industry to begin requiring use of standard data exchanges in projects and will ensure that these exchanges can be verified throughout the course of these projects. ■

Part 2 of this article will be released in the Spring 2008 issue of JBIM, will walk through examples of this standard BIM View development process and will also show how they can be used in building projects to enable new business processes that will improve data sharing, improve project efficiencies, improve construction quality, and reduce costs through error avoidance.

REFERENCES

[1]Building Product Models: Computer Environments Supporting Design and Construction—Eastman, 1999.

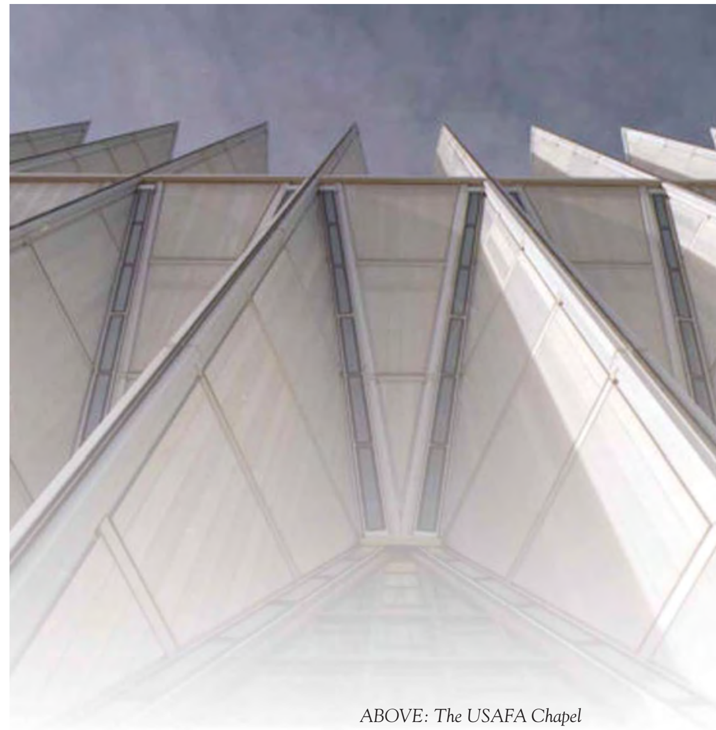
[2]ISO TC184/SC4 is responsible for the ISO 10303 (STEP) standard—www.tc184-sc4.org.

[3]Input from Jiri Hietanen—Research Scientist, Tampere University of Technology.

BIM Effects on Construction Key Performance Indicators (KPI) Survey

By Patrick C. Suermann, Maj, USAF, P.E., Ph.D. Candidate, The University of Florida AND
Raja R.A. Issa, Ph.D., J.D., P.E., Professor, The University of Florida

RECENTLY, RESEARCHERS FROM THE M.E. Rinker, Senior, School of Building Construction from within the College of Design, Construction and Planning at the University of Florida launched a survey with the help of NIBS. The survey's goal was to document experts' *perceived* impact BIM has on the *construction phase* of the facility lifecycle using six commonly used metrics or KPIs in the construction industry. Hopefully, after documenting the experts' opinions, further research can be oriented to adequately focus on the metrics where BIM has the strongest effects. The response rate was overwhelming, and although it was a simple survey, the information below shows tangible and significant evidence about the respondents' perceptions about BIM's effects on the construction phase of the facility lifecycle.



ABOVE: *The USAFA Chapel*

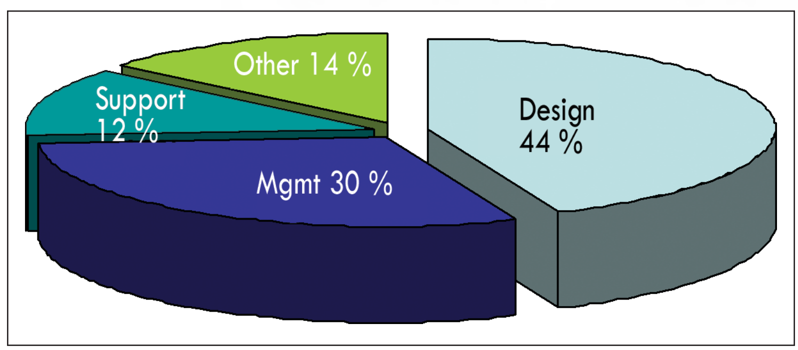
DEMOGRAPHICS

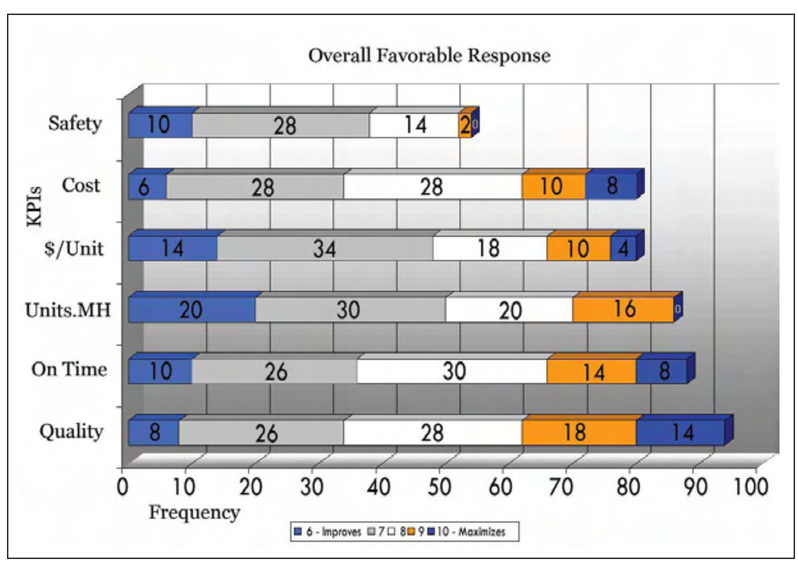
- Number of Respondents
  - 50 completed surveys
  - 50/105 represents 48% of the NBIMS listserv
- Age: Normal distribution
  - Single Largest Group
    - 45-54 year olds
- Education
  - Single Largest Group
    - 56% hold graduate degrees
- Organizational Roles
  - Design Roles: 44%
  - Management: 30%
  - Support Roles: 12%
  - Other: 14%

BIM EFFECTS ON KPIs

Percent of responses favorable to BIM (in rank order):

1. Quality Control: 90%
2. On-time Completion: 90%
3. Cost (Overall): 84%
4. Units/Manhour: 76%
5. Dollars/Unit: 70%
6. Safety: 46%





KPIs MOST FAVORABLY AFFECTED BY BIM

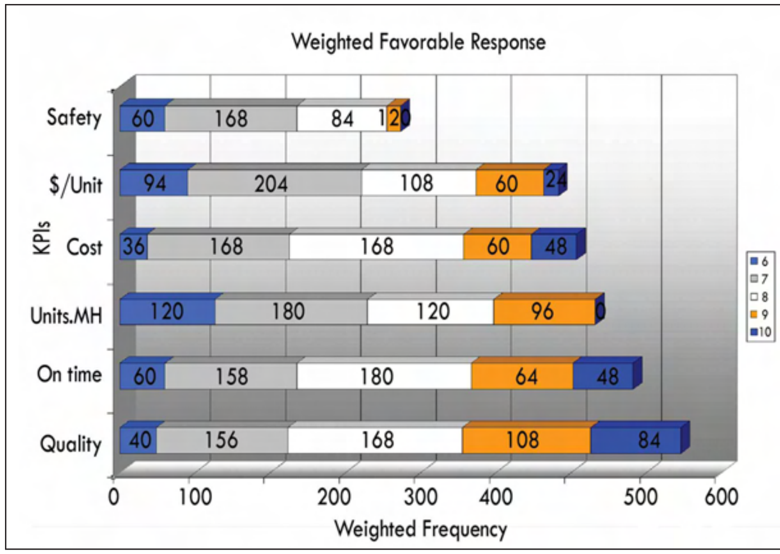
1. Quality
2. On time completion
3. Units/Manhour

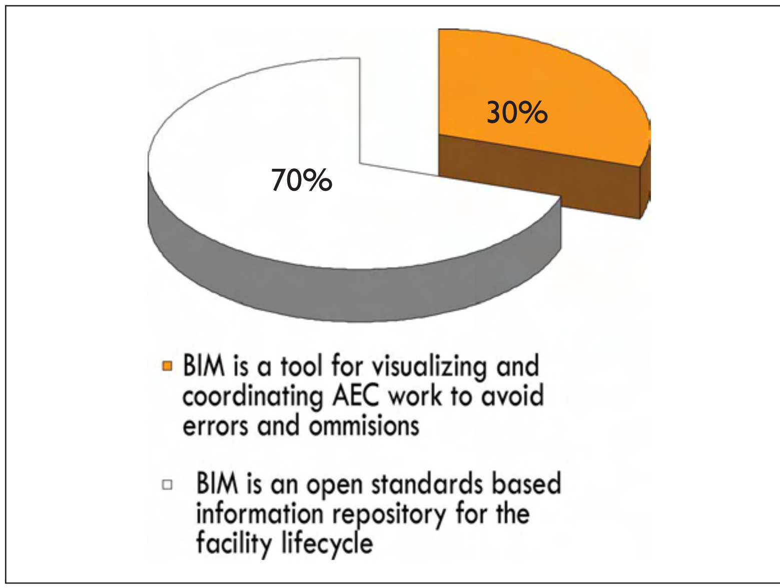
RESPONDENTS' OBSERVATIONS:

- "While BIM is a goal to strive for and is relevant to certain projects - the fractured nature of the A/E/C industry means that it will be a long time before BIM has a significant overall effect on the industry."
- "Quantification of reduced O&M costs is essential."
- "More KPIs: Reduction in Claims, Improved public outreach/agency coordination, More sustainable structures."

As the results suggest, the respondents felt that BIM is most likely to positively affect construction KPIs regarding quality control and on time completion. More research needs to be conducted in order to corroborate the BIM-favorable results here. While the respondents are certainly knowledgeable about BIM because of the demographics shown herein and membership on the NBIMS listerv, their affiliation could have also biased the results. Additionally, quantifying the impact of a BIM approach through real world construction case studies will offer a more compelling argument for BIM adoption by AEC firms. ■

The researchers would like to thank NIBS, the NBIMS team, and JBIM for helping to draft, host, and publish the results of this survey. For more information about this survey or future BIM research, please contact the researcher Patrick Suermann, P.E. via email at suermann@ufl.edu or Dr. Raymond Issa at raymond-issa@ufl.edu.





BIM for Construction Handover

By E. William East, PE, Ph.D., Engineering Research and Development Center, AND William Brodt, NASA

PROBLEM

Along with the keys, facility managers typically receive many "bankers' boxes" full of information about their facilities at construction handover. This information is provided in paper documents that describe equipment warranties, replacement parts lists, building system operating instructions, maintenance job plans, and fixed asset lists. Today those who use the information provided must, at best, pay to have the data keyed into the relevant data systems. At worst, facility maintenance contractors are paid to survey the existing building to capture as-built conditions. In these cases, owners pay twice—once for the construction contractor to complete the documents at the end of construction and again for the maintenance contractor survey.

There are several problems with the current procedure for construction handover documents. First, construction contractors are required, at the end of a job, to recreate and collate information that has been created by others. Since the construction contractor is not the author of the majority of the information provided, requiring the contractor to recreate the information introduces errors. Second, waiting until the end of the construction contract to receive the information often results in less than satisfactory deliverables, many of which are available earlier in the project, but are not captured.

"Failure of facility management organizations to create standardized, centralized data repositories typically results in information being stored on multiple servers with incomplete access. In the worst case, the data remains in the desk drawer of the individual who ultimately received the disk."

Next, the format of the information exchange is inadequate to allow others to effectively use the information provided. Paper-based documents are often lost, cannot be easily updated and take up a large amount of space. Finally, the information provided is often insufficient to ensure that replaced equipment can be specified to ensure compliance with design intent.

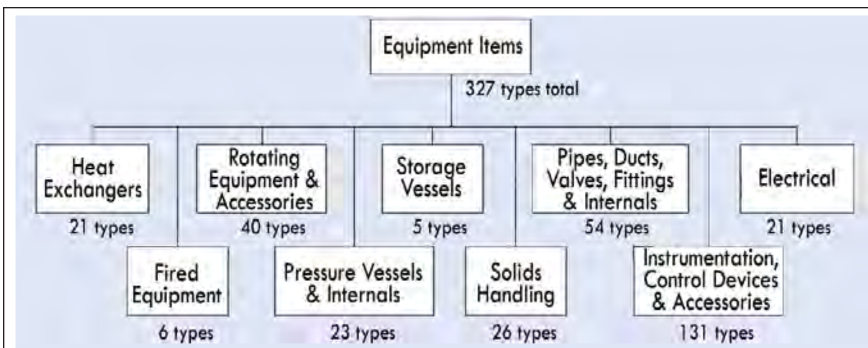


Figure 1 - AEX project entities.

BACKGROUND

In the1990s, the National Institute of Building Sciences, Facility Maintenance and Operations Committee started work to define a standard through which construction handover documents could be captured electronically based upon concepts developed within the Federal Facilities Council [Brodt 1993]. The data structure followed the format defined in the Unified Facility Guide Specifications, Operations and Maintenance Support Information (OMSI) [UFGS 2006].

The typical submittal process requires the construction contractor to provide all cut sheets, shop drawings, etc...as part of the quality control contract requirements. Later the contractor provides the installation information that accompanies installed equipment. Finally systems information is created by the contractor to provide instructions to facility maintenance personnel. The contractor must provide a complete set of all this information as part of handover documents.

In the OMSI approach, images of contract documents already required in standard federal specifications were compiled and indexed, first in hardcopy volumes and later in Portable Document Format (PDF) files. While having all the information electronically available in a single location proved helpful, serious problems existed with this method of delivery. First, scanning existing paper contract documents submitted during the course of public construction is expensive. Commercial contractors providing OMSI creation services typically charge $40K per capital project. OMSI handover documents typically result in a single compact disk with all construction handover data. The cost of OMSI data is an additional cost incurred by the owner to reformat data that already is provided by the construction contractor. Failure of facility management organizations to create standardized, centralized data repositories typically results in information being stored on multiple servers with incomplete access. In the worst case, the data remains in the desk drawer of the individual who ultimately received the disk.

While the author's experience has been associated with large public sector contracts, private owners are certain to have similar problems. An example provided to the authors in November 2006 confirms that private sector projects are not currently capturing information during the process of construction but are also conducting post-construction surveys. The cost of these surveys, according to interviews conducted by the authors, in commercial build-operate configuration is an internal, unburdened cost of $25K. For small projects, it is no wonder that more than one contractor has left the job, and forfeited retainage, rather than complete the as-built survey.

In interviews with public agencies as recently as March 2007 the first author confirmed that at least one public building owner paid three times for construction handover information. First, the information is included in the cost of completing the design and construction of the project. Second, the information is re-collected at the end of the construction phase and provided in paper boxes along with the keys to the new facility. Since the information in the paper boxes cannot be directly loaded into maintenance management software, the agency pays for the operations contractor to survey the building again to identify existing equipment locations, serial numbers, etc... at the start of their operations contract. The failure of existing handover requirements cannot be more clearly seen than in the case where the construction contractor provided information is, essentially, discarded twice.

While the focus of the information exchanges identified above has been related to the data required by those responsible to maintain facilities, additional problems have been encountered related to the lack of operational and asset management information.

Replacement of specific equipment is made more difficult when the product data is not readily available to public works department or building manager. Rather than retrieving the electronic information and starting a procurement activity, the manager must track down the information on the existing equipment to determine what needs to be purchased. A minimum of one site visit to capture nameplate data, and several hours on the phone is required for each piece of equipment that does not have its own electronic description.

Replacement or repair of equipment that is no longer manufactured is a much more difficult task. Even if the original equipment information was provided, without the design loads associated with the equipment, the building manager doesn't know how close the installed equipment matched the design requirements. Failure to consider the required design loads will result in safety problems, shortened product life, or higher than required cost of replacement part.

PATHS FORWARD

In 2000 the Facility Maintenance and Operations Committee (FMOC), National Institute of Building Sciences

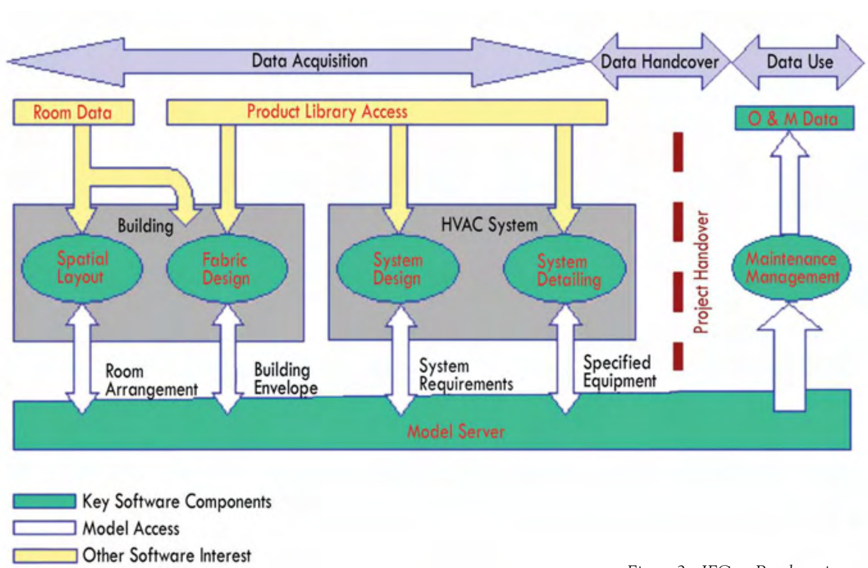


Figure 2 - IFC -mBomb project.

(NIBS) was awarded a grant from the National Performance Review (a component of Vice President Al Gore's Reinvention of Government effort) and commissioned a study to investigate the ability of the OMSI data to be structured to provide critical information from within the OMSI files as separate data elements. This effort created an eXtensible Markup Language (XML) schema that would organize the Portable Document Format (PDF) files merged into an OSMI data file [FFC 2000]. The project was successful in demonstrating that product manufacturers data could be directly provided to owners Computerized Maintenance Management Systems (CMMS) and that software companies could use the schema to extract relevant data from test files. The main difficultly with implementing this work was that the identification the information exchange paths between owner and manufacturer were not fully identified. The schema was incorporated into the International Alliance for Interoperability's Industry Foundation Class model [IAI 2003].

Concurrent with the FMOC project, the National Institute of Science and Technology (NIST) and FIATECH were developing a data exchange format to support the life-cycle information needs for industrial equipment construction. The Automating Equipment information eXchange (AEX) project evaluated the shared information requirements to design, procure, and install centrifugal pumps [Turton 2006]. **Figure 1** identifies the entities created for the AEX project [Teague 2004]. One of the best results of this project, from the point of view of operability, was that only a very limited subset of each individual stakeholder's information needed to be exchanged among all parties in the context of heavy industrial construction.

In 2002 an international project, named "IFC-mBomb," demonstrated one approach to capturing data during design and construction, then handing over the data to facility operators. The framework for the project, completed in June 2004, is shown in **Figure 2**.

Within the last several years U.S. Army, Department of Public Works (DPW), Fort Lewis, WA began to consider the use of spreadsheets to capture a minimum subset of critical information needed by the DPW between the acceptance of a project at beneficial occupancy and the full financial handover. By having the contractor fill in required spreadsheet fields, the DPW had planned to capture equipment lists and preventative maintenance activities that were required before beneficial occupancy.

Regardless of the approach taken, these groups searched for a no-cost, sustainable approach that would ultimately create a single set of data that could be directly loaded into Computerized Maintenance Management Systems (CMMS), Computer Aided Facility Management (CAFM), and Resource/Asset Management Systems (RAMS).

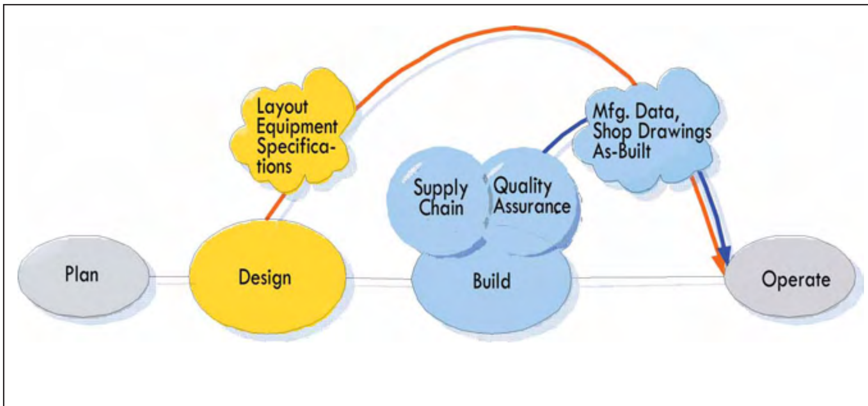


Figure 3 - COBIE data capture.

THE COBIE PROJECT

With the completion of the International Alliance for Interoperability, Industry Foundation Class (IFC) model (version 2x3), the stage was set for the development of exchange standards based on international standards. In 2005, the Facility Information Council of the National Institute of Building Sciences (NIBS) formed the National Building Information Model Standard (NBIMS) effort [NBIMS 2006]. One of the objectives of this group was to speed the adoption of an open-standard BIM, through the definition of information exchange standards based upon the IFC model.

Given the work that preceded NBIMS related to facility operations and maintenance, a project was started under NBIMS to support the handoff of projects between builders and operators. The Construction Operations Building Information Exchange (COBIE) project was initiated in December 2006. The objective of this project is to identify the information exchange needs of facility maintainers, operators, and asset managers of data available upstream in the facility life-cycle (for example, during design and construction).

The COBIE project acknowledges the practical constraint that much of today's information content is locked within documents or images of paper documents. An example of the type of information currently locked in e-paper documents that are of critical importance to facility maintenance personnel are replacement parts list. If the data was available in an interoperable format, Information Technology (IT) integration efforts would allow the maintenance worker to directly order parts during the triage of malfunctioning equipment. COBIE is designed to allow the current e-paper documents to be transmitted, but when manufacturer provided data is available, COBIE may also directly accept that information.

Several critical individual data elements were, however, identified by facility maintainers, operators, based and asset managers. The COBIE team concluded that the minimum critical set of data needed by O&M staff is the location, warranty duration, and parts suppliers for installed equipment. For asset managers the COBIE team indicated that area measurement and property replacement values were of critical concern. Other information needed may, for the time being, be captured through the association of documents to specific BIM entities.

The COBIE Pilot implementation standard was published as Appendix B of the National Building Information Model Standard [NBIMS 2007]. The underlying IFC model description of the COBIE Pilot standard was also published for international evaluation [IDM 2007].

COBIE EARLY ADOPTERS

While the COBIE format has not been fully evaluated by all members of the design, construction, operations, maintenance, and asset management communities, some organizations are taking the steps to implement the current pilot standard. For example, several federal agencies have, or are in the process of, including COBIE requirements in their contracts: the General Services Administration, Corps of Engineers, Department of State, and National Aeronautics and Space Administration. The need for COBIE data is so critical that the U.S. Army is working to adopt COBIE as the required import mechanism to translate asset data and maintenance management requirements into their financial system.

Of critical concern to this project, and other NBIMS development projects, is that the information required for the exchange is already captured, or can easily be captured, within the context of existing IT and contract practice. While a future practice of shared BIM's for all project teams is a commendable goal, near-term projects must be executed within the context of existing contract documents that include options for COBIE data. The capture of COBIE data currently takes place at the conclusion of construction. The clearest implementation of COBIE is to simply replace the requirement to provide banker's boxes with the COBIE data disk. Of course, this is not very efficient given that the majority of the data required at building handover is created by designers or manufacturers.

Some project teams and owners are considering the adoption of IT that would allow the capture of COBIE data during the design and construction life cycle. Design-build firms may use BIM software and capture COBIE data as the project progresses from inception to completion. Owners may require the submission of partial COBIE data sets based on the timing of when the data is created as shown in **Figure 3**. Designers load COBIE data sets with room function and layout, named equipment and specifications requirements. During construction, manufacturers' data captured from the contractors' procurement processes is captured along with as-built changes to building layout and equipment position. Capturing the data as it is created will increase the accuracy of the "data commissioning" process and reduce contractor's cost since design and manufacturer data will no longer have to be transcribed during post-construction surveys.

Today there are two NIBS-sponsored efforts underway to support COBIE. The first is the post-project creation of a COBIE data set for a completed project. The objective of this project is twofold: (1) to provide an example of a COBIE data set and (2) to create a COBIE guide book to assist contractors to complete the COBIE spreadsheet. The objective of the second project is to (1) provide an IFC to COBIE spreadsheet translator using the IFC 2x3 coordination view as the baseline, (2) provide two sample COBIE spreadsheets, and (3) provide tools that would allow the comparison of incremental submissions of COBIE data. At this time there are three firms who can assist in the creation of COBIE data for specific projects Burns&McDonnell, Peripheral Systems Inc., and AEC3. TMA Systems a CMMS vendor has also been working toward importing COBIE data sets.

BROADER SIGNIFICANCE

There has been much "philosophical" discussion of open-standard BIM and its impact in the NBIMS Version 1.0, Part 1, the FIC-BIM list server, and general public and trade publications. From the authors' point of view, these discussions have begun to whet the appetite of users who need open-standards based BIM information exchanges. The inclusion of the COBIE Pilot standard in the multiple agencies' federal government construction contracts is the first result that begins to practically address the life-cycle information exchange needs of our capital facilities industry. As the construction of these projects near completion a follow-on paper will document the results of these efforts.

The potential for capture and transmission of COBIE data through design and construction, with the inclusion of information provided by product manufacturers provides a compelling business case for the adoption of life-cycle BIM that goes beyond the discussion of 3-D CADD.

The development of COBIE demonstrates the benefits that can be achieved using a requirements-driven approach. Through a requirements-drive approach different groups of constituents that exist naturally in our industry today are able to their information needs. These needs are consistently translated into the IFC model through NBIMS and IAI with appropriate implementation standards that facilitate the capture and transmission of the data. By the consistent definition of each of these groups the answer to the question "What is a BIM?" can be answered at the level of specificity that allows open-standard interoperability.

ACKNOWLEDGEMENT

The authors would like to thank the National Institute of Building Sciences for its support of the National Building Information Model Standard activities. Some of the organizations making a direct significant contribution to the COBIE project include (in alphabetical order): AEC3, Burns & McDonnell, National Aeronautics and Space Administration; Peripheral Systems

Inc., National Institute of Science and Technology, TMA Systems, Engineer Research and Development Center, and the U.S. Department of State, Overseas Buildings Operations. ■

E. William East, PE, Ph.D., is a Research Civil Engineer for the Engineering Research and Development Center. William Brodt is an Experimental Facilities Engineer, Facilities Engineering and Real Property Division at NASA.

REFERENCES

[Brodt 1993] Brodt, William and Fardig, Paul, "Electronic Maintenance Data Input Standards - Level One", in "Developing Data-Input Standards for Computerized Maintenance Management Systems," Federal Construction Council Consulting Committee on Computer Applications, National Academy Press, Washington, DC, 1993

[FFC 2000] Linking the Construction Industry: Electronic Operations and Maintenance Manuals - Workshop Summary, Federal Facilities Council Technical Report #140, National Academy Press, Washington, DC, 2000

[IAI 2003] International Alliance for Interoperability, "IFC Model: 2x3," http://www.iai-international.org/Model/R2x3_final/index.htm

[IDM 2007] Information Delivery Manual, http://www.iai.no/idm/index.html

[NBIMS 2006] National Building Information Model Standard, http://www.facilityinformationcouncil.org/bim/

[IFC 2002] IFC Model Based Operation and Maintenance of Buildings (IFC-mBomb) http://cig.bre.co.uk/iai_uk/iai_projects/ifc-mbomb/

[NBIMS 2007] National Building Information Model Standard, Version 1, Part 1. http://www.facilityinformationcouncil.org/bim/pdfs/NBIMSv1_ConsolidatedAppendixReferences_11Mar07_1.pdf

[Teague 2004] Teague, Tom "cfiXML Schema Architecture," FIATECH AEX Project, June 2004, presentation.

[Turton 2006] Turton, Mary, Palmer, Mark "Summary of AEX Schema update and Supporting Rationale," National Institutes of Standards and Technologies, Public Release 2.0

[UFGS 2006] Unified Facility Guide Specifications, "Submittal Procedures," UFGS 01 33 00 Submittal Procedures, October 2006. (formerly NAVFAC 01781)

Convergence and Standards

How the domains of architecture, engineering, construction, building owners and operators (AECOO) and geospatial technology are uniting to improve decision-making for facilities managers and the urban enterprise

By Mark Reichardt, President, Open Geospatial Consortium, Inc.

INTRODUCTION

Traditionally, architecture/engineering/construction (AEC) and GIS users created digital data for specific projects or business objectives. Quite often, there was no commitment to effectively sharing these data between the two domains. More recently, many business drivers, including cost reduction, have created an awareness in both domains that the data's value extends well beyond its original purpose. For almost any building or geospatial data, there are many likely or possible future uses as well as possible immediate secondary uses.

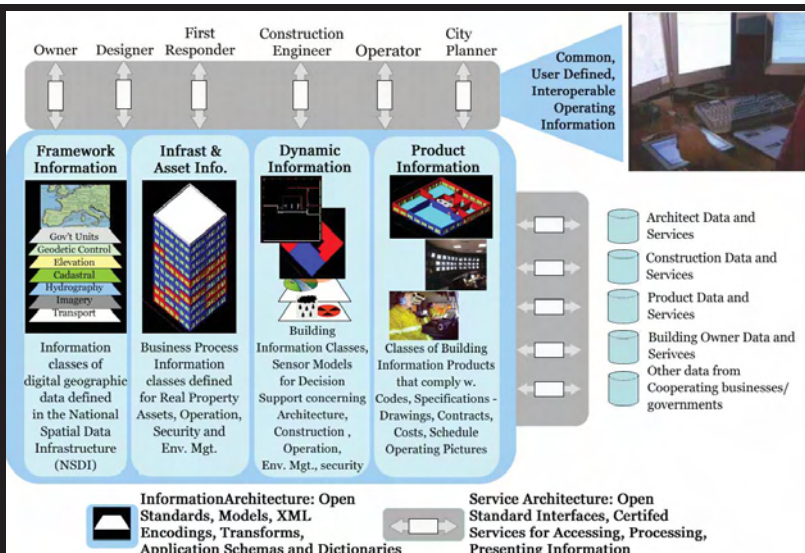


Figure 1 - NBIMS, OGC, buildingSMART alliance™, IAI and other organizations are working cooperatively to advance an environment where standards and best practices enable the management and exchange of BIM and geospatial information to meet an array of needs. (Figure copyright OGC).

Figure 2 - "Levels of Detail" (LoD) in CityGML. CityGML is an open data model and XML-based format for the storage and exchange of virtual 3D city models. It is an application schema for Geography Markup Language 3 (GML3), the extendible international standard for spatial data exchange issued by the OGC and ISO TC211. CityGML is an OGC Best Practice Paper.

The AEC industry has been making great strides in transitioning from the 2-dimensional paper world to the virtual world of Building Information Models (BIMs). In addition to supporting 3D and 4D visualization and analysis, BIMs enable easier management and exchange of detailed building information among multiple stakeholders throughout the life cycle of a building.

This article explores how cooperation between AEC and geospatial standards organizations is helping to advance the interoperability necessary to benefit those directly involved in the building lifecycle, as well as the first responders, urban planners, utility service providers, insurers, and others who support the broader urban environment.

THE NEED FOR CONVERGENCE

NIST (the National Institute of Standards and Technology) undertook a study in 2004 to estimate efficiency losses in U.S. commercial and institutional buildings and industrial facilities. NIST found that, in 2002, the annual cost associated with inadequate interoperability among computer-aided design, engineering and software systems was $15.8 billion.

More than half of this cost is borne by capital facilities owners and operators in the course of ongoing facility operation and maintenance. The information that facility managers need for routine and unexpected tasks is often not available and often needs, somehow, to be recreated.

Much of the information, of course, was originally available in documents created by the planners, architects and engineers who sited and designed the building and by the construction company and contractors who built the building. Some data was available from the engineers who did the mechanical and electrical systems, site work, landscape design, and utility connections. Some data was obtained by design teams from manufacturers of building components. Some documents were filed by or with city agencies. Aerial imaging firms provided imagery. Documents were created as well by law firms, insurance firms, financial institutions, brokers and realtors who had business dealings with the building's designers, builders, owners, tenants and professional management firms.

Unfortunately, in most cases, most of these documents are difficult to find months or years after they were created. Not only are documents hard to find, but because data cannot be maintained and enriched through the building lifecycle, there is tremendous potential for error and cost overruns as the building lifecycle progresses.

Complicating this situation is the growing need to leverage both building and geospatial information to support and facilitate facilities, neighborhood and broader urban planning requirements; improve delivery of services; assure adequate safety and security procedures; and meet an array of other needs that rely on the integration of AEC and geospatial information. Convergence is necessary to analyze, model, understand and deal with very complex and critical issues. One example is analyzing pathways and timing of air flow through a subway system and into building infrastructure and other urban spaces for emergency preparedness. Another example is evaluating the costs and benefits associated with repurposing a building, considering all relevant factors, such as cost of changes to mechanical systems (plumbing, electrical, HVAC etc.); projections of revenue with or without renovations; occupancy history and alternative marketing scenarios; codes, permits and licensing; and transportation and parking.

PROGRESS TOWARD CONVERGENCE

The AECOO community is increasingly requesting provision of BIM information in their contracts to reap the benefits of improved quality and reduced life cycle costs related to business processes. So the time is now rapidly approaching when convergence of geospatial and building information can be achieved.

In fact, implementation of the concept has been ongoing. Most of the design software companies began years ago, for example, to provide their customers with improved integration of CAD and geospatial technologies. This has taken time, because these two kinds of spatial technologies are very different at a basic level. But market acceptance of integrated design/geospatial suites has been strong, and the work done by these vendors has increased their customers' awareness of the value of BIM.

Progress has also been facilitated by the Web. Web based distributed computing based on Web services (online processing services) lends itself to solutions that involve integration of diverse kinds of information stored on and served by networked computer systems. The eXtensible Markup Language (XML) offers a standard way for data files and Web services to be "self-describing". This creates the potential for a Web-wide "card catalog" system for discovery of data and services through the publishing of metadata (data about the data) in catalogs and directories. It also enables Web services to discover how the data needs to be processed. Indeed, the AECOO community has embraced key XML encodings to help automate information exchange, such as: Industry Foundation Classes (IFC), a data representation standard and file format for defining architectural and constructional CAD graphic data as 3D real-world objects; AGCxml, an XML schema for electronic interchange of common construction data and documents; and aecXML, a data representation standard designed for all the non-graphic data involved in the construction industries. However, harmonization of these, and additional web services interfaces, defined as open standards, will be necessary to move BIM lifecycle management to a truly automated process.

It is worth noting that geospatial processing services have been some of the first capabilities to make the transition to Web services. This proves that Web services can serve complex application domains if a critical mass of industry stakeholders work together in an open and formal standards process such as that provided by the Open Geospatial Consortium, Inc. (OGC).

The Web favors standards because, in general, the value of a data set or service increases with the number of users who can use it, and free and open standards tend to increase the number of users. So the Web is based largely on free and open standards developed by a variety of consensus standards organizations, such as the W3C (World Wide Web Consortium), OASIS (Organization for the Advancement of Structured Information Standards), the Web3d Consortium, and the OGC.

To facilitate lifecycle building process integration and sharing of digital datasets, the National Institute of Building Sciences formed a committee in early 2006 to create a National Building Information Model Standard (NBIMS) to provide a common model for describing facility information exchanges. The committee is comprised of a carefully selected group of leaders representing the full spectrum of AECOO stakeholders. Work programs were planned, funding was obtained, and teams of developers have been making good progress toward completion of the standard.

In addition, the AIA is reviewing their contract documents to enable automated transfer of a BIM in which the BIM and the intellectual property it represents can flow from the architect to the owner and operator.

Other data creators are confronting requirements to do the same. Government agencies such as the U.S. General Services Administration (GSA) now require delivery of spatial program information from BIMs for major projects that are receiving design funding in Fiscal Year 2007 and beyond. The Government's requirements tend to make sense to private sector owners and operators, so data creators are gearing up to fit BIM into their business processes. Some observers anticipate the emergence of a new group of companies whose main work will be BIM management.

The AECOO community is making great strides. NBIMS is defining data exchanges around the building lifecycle. Other standards efforts are developing XML encodings to deal with various aspects of data exchange, such as the IFC, AGCxml, and aecXML encodings noted above, and CityGML shown in **Figure 2**.

But in order for all of this to work fluidly in an automated fashion, the stakeholder industries need a common Web services infrastructure. The OGC has already developed an open standards service oriented architecture (SOA) framework and has also developed collaborative partnerships with the buildingSMART alliance™, IAI chapters and others to help advance the SOA framework. Additionally, OGC is organizing collaborative testbed activities that unite users and industry technology solution providers to validate BIM standards and develop and promote related standards that enable the convergence of AEC and geospatial information. Security and rights management are among the requirements set forth in testbed scenarios.

The ability to improve quality and reduce cost over the lifecycle of a building is a major value point for standards-based BIM. The value proposition is further expanded if one also takes into account the potential for the convergence of BIM and geospatial information to improve decision making related to broader community and urban planning and problem solving. These cumulative social benefits make the case for standards based BIM/geospatial convergence incontrovertible. ■

Mark Reichardt is President of the Open Geospatial Consortium, Inc. He works with the building standards community to advance seamless integration of geospatial and BIM information to address critical urban planning, safety, security and operations requirements.

NBIMS COMMUNICATIONS TASK TEAM

Chair: Patrick Davis, HNTB Architecture

The purpose and ongoing work of the NBIMS Communications Task Team (CTT) is facilitating both internal and external communication needed to develop and implement the NBIM Standard and communicate NBIM Initiative concepts. Through direct creation, coordination of creation by others and management of content, CTT works to inform and educate the Committee and the Community about NBIMS issues, development and practical applications. CTT has been closely involved in producing the National Building Information Modeling Standard Version 1—Part 1: Overview, Principles and Methodologies and in developing JBIM—the Journal of Building Information Modeling. JBIM will be a valuable asset for NBIMS as it supports discussion in the Community and provides a conduit for externalizing the work of the Committee. We invite those who believe the message of NBIMS is important to join CTT and make their contribution to industry transformation through this critical activity.

NBIMS SCOPING TASK TEAM

Chair: Dianne Davis, AEC Infosystems, Inc.

The Scoping Task Team has responsibility to identify the current state of BIM capability in the North American Architect/Engineer/Construction/Owner/Operator (A/E/C/O) Community and develop a "Roadmap" for strategies and solutions to further BIM implementation within the industry. The Scoping team employs a broad and future focused perspective on BIM use, awareness of industry needs, and an understanding of existing information classification systems to organize and facilitate subject matter experts who can specify sets of information requirements needed in specific business contexts. Scoping Team members are every day practitioners, educators and researchers with knowledge of typical business processes. Currently, Scoping Team is working to identify gaps in methods for describing information requirements and additional building information taxonomies needed as a foundation upon which to build BIM modeling and content standards. Team members are also working on web-based tools for use in creating and cataloging BIM model requirement definitions in a publicly accessible resource.

NBIMS DEVELOPMENT TASK TEAM

Chair: Bill East, CERL

The NBIMS Development Teams assists teams to describe specific business problems in the building lifecycle domain that would benefit from improved information exchanges. Development organizes project teams that identify business processes, data requirements, and data schema mappings needed to solve specific information exchange problems. While the NBIM Standard development process is being finalized, the Development Team has continued to address the needs of the industry by carrying out projects that will be submitted for NBIM Standard review when the agreed process becomes available in early 2008. The products of the Development process are specifications and encodings that can be offered to software developers for incorporation in BIM applications that end-users can employ to author, exchange, analyze and report on buildings and building-related elements.

Current project teams include: Construction to Operations Building Information Exchange (COBIE), Early Design Information Exchange (EDIE), International Building Code Checking, Structural Steel Design, Precast Concrete Design, and Specifiers' Property Set Definition. Information on these projects will be available through upcoming NBIMS publications such as fact sheets and technical reports.

Two additional projects related to Cost Estimating and 5D Scheduling are looking for additional members. These projects would welcome individual subject matter and stakeholder participation. Sponsorship of existing and new projects is welcome.

MODELS AND IMPLEMENTATION GUIDANCE TASK TEAM

Chair: Richard See, Digital Alchemy

Models and Implementation Guidance (MIG) team will be creating BIM data models that satisfy the Exchange Requirements (ERs) defined in the Scoping and Development task teams. These "Models" will be specified in established standard formats that provide unambiguous guidance and provide a process/methodology for certification testing to software vendors looking to implement support for the National BIM standard in software products. Additionally, the MIG task team will provide support to such implementers and facilitate collection of their feedback to the NBIMS models for improvement.

To date, MIG has been actively involved in defining and gaining agreement on the specific processes, tools, vendor relationships, etc. MIG will use to carry out its charter. Beginning in 2008, MIG is planning to begin processing early information exchange requirement definitions into NBIM Standard products.

TESTING TASK TEAM

Chair, Patrick C. Suermann, Maj, USAF, P.E.

The Testing Task Team has assisted the Committee to investigate and identify the need for methods of inspecting and evaluating a wide range of products, processes and individual capabilities related to BIM Standard development, implementation, and end-use. As of June 2007, Testing Task Team had designated the following lead roles for each of these areas:

- Chris Hubbard, Quarry Group; lead for Processes (i.e.: consensus, validation, data interoperability).
- Brian Russell, ASG Inc; lead for Products (i.e.: software, NBIMS Capability Maturity Model, relationships with other software testing groups).
- Patrick Suermann, UFL; lead for People (i.e.: surveys of industry practices, descriptive demographics, education, etc.).

The Testing Task Team has focused a considerable percentage of its effort on two projects:

a. A project to test and suggest further development of the Capability Maturity Model (CMM) using the AIA Technology in Architectural Practice (TAP) BIM 2007 Award winners. The project involves applying the CMM to these projects; thought to represent some of the best examples of BIM use in practice. Results of this project will be published in November 2007.
b. Research into demographics and associated beliefs of constructors on the recent effects of available BIM technology and implementation. This research is complete and available by contacting Patrick Suermann or by visiting the NBIMS website.

BUSINESS PROCESS INTEGRATION TASK TEAM

Chair: David Jordani, Jordani Consulting, Inc.

The BPITT is less focused on the information requirements and technology of BIM in favor of focusing instead on productive use and leveraging of new capabilities and responsibilities technology and interoperable data will present to practitioners and institutions engaged in all aspects of the facility life cycle. Members of BPITT include practitioners and allied professionals, software vendor executives, lawyers and educators.

BPITT has formed a legal topics advisory group lead by Howard Ashcraft, individual members have formed and participate in local BIM-related issues discussion groups, and a liaison arrangement with the newly formed buildingSMART alliance™ is being developed to explore initiatives in the areas of higher and adult continuing education and workforce development. ■

JOIN the buildingSMART alliance™ and/or JOIN the NBIMS Project Committee

Please complete to apply for membership in the buildingSMART alliance™. All application forms are subject to verification. If you only wish to receive general information please select General buildingSMART alliance™ discussion listserv option below.

Name ______________________________ Title ______________________________
Organization ______________________________ Address ______________________________
City ____________________ State ______________ Zip ____________________ Country ______________
Phone ____________________ Mobile ____________________ Fax ____________________
Email ______________________________

Complete and submit the following form to apply to the National BIM Standard Project Committee. All application forms are subject to verification.

Level of Participation (check all that apply)

❑ Listserv-Interested in becoming NBIM Listserv Member
❑ Committee-Interested in joining the Committee and develop Ballot items
❑ Consenus-Interested in participating in the Voting Process for the Standard
❑ Sponsor-Interested in providing resources (funding or in-kind support)

Listserv participation: ❑ General buildingSMART alliance™ discussion ❑ Member only list

Membership Interest Classification

The purpose of the "interest classifications" is to ensure an appropriate representation of the various interests of the building community in the makeup of the project committee. Please check the one category which is most appropriate for you. Institute members are categorized in one of the following twelve (12) classifications based on their primary trade, occupational or business affiliation. Representatives of trade and professional associations and societies are categorized in the interest classification they primarily represent. Consultants, private attorneys and other similar individuals are classified in categories they predominantly serve. **Please select only one.**

❑ Consumer and General Interest	❑ Architects	❑ Engineers	❑ Real Estate, Finance or Insurance
❑ State and Local Government	❑ Building Construction	❑ Labor Organizations	❑ Building Materials, Products or Software
❑ Housing	❑ Standards	❑ Federal Government	❑ Research, Testing or Other Services

Membership Level

Associate:	NIBS MOU Holder, Councils, Committees (Please contact NIBS directly)	
Member:	Student	❑ $25.00
	Individual	❑ $100.00
	State & Local Government	❑ $1,000.00
	Federal Government	❑ $5,000.00
	Gross Annual Income Based	❑ $1,000.00 (<$10M)
		❑ $2,000.00 (<$50M)
		❑ $3,000.00 (<$100M)
		❑ $4,000.00 (<$250M)
		❑ $5,000.00 (>$250M)
Sponsor:	Alliance Sponsor	❑ $10,000.00
	Bronze Sponsor	❑ $25,000.00
	Silver Sponsor	❑ $50,000.00
	Gold Sponsor	❑ $100,000.00
	Platinum Sponsor	❑ $250,000.00

Please send check made out to: NIBS - buildingSMART alliance™ and send to 1090 Vermont Avenue, NW, Suite 700, Washington, DC 20005-4905. For more information please contact Deke Smith AIA, Executive Director, buildingSMART alliance™ at dsmith@nibs.org or (202) 289-7800 or (703) 909-9670.

Please support our advertisers who help make this publication possible.

M.E. Rinker, Sr.
School of Building Construction
University of Florida
and
The LAISERINLetter(tm)

Jointly Present and Co-Host
BIM4Builders(tm)
An Industry Conference on Applications of
Building Information Modeling In Construction:
Cases, Analyses, Tools and Best Practices

May 11-13, 2008
Gainesville, Florida

www.BIM4builders.com

SAVE THE DATE!!!
MAY 11-13, 2008
BIM4builders(tm)

An Industry Conference on
Applications of
Building Information Modeling
in Construction:
Cases
Analyses
Tools
Best Practices

Jointly Presented and Co-Hosted by
M.E. Rinker, Sr.
School of Building Construction
University of Florida
and
The LAISERINLetter(tm)

For More Information:
www.BIM4builders.com